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Meetings

Society of Automotive Engineers, Annual Meeting—January 22, 23, 24 and 25, Detroit, Michigan.

•

American Society of Testing Materials, Committee D-2—March 5, 6, 7, 8 and 9, Washington, D. C.

•

American Association of Petroleum Geologists—Third or fourth week in March, Dallas, Texas.

•

International Petroleum Exposition—May 12 to 19, inclusive, Tulsa, Oklahoma.

•

Natural Gasoline Association of America—May 9, 10 and 11, Tulsa, Oklahoma.

•

American Petroleum Institute, Mid-Year Meeting—May 22, 23 and 24, Wm. Penn Hotel, Pittsburgh, Pennsylvania.

•

American Petroleum Institute, Fifteenth Annual Meeting—November 12, 13, 14 and 15, Dallas, Texas.

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The Course of Oil

By K. C. SCLATER

Perfecting the Code Regulations

More effective regulation of the petroleum industry in the United States is still being sought whereby it is hoped permanent stabilization, satisfactory to the oil industry itself and to the public, may be attained. Controlling the production of crude is only one-half the problem. It becomes increasingly evident that unless the manufacture and the marketing of refined petroleum products are subjected to strict regulation of some sort throughout the nation, further efforts put forth to reach the desired goal may be seriously hampered or entirely vitiated.

For the present at least, it seems likely that instead of outright price-fixing measures, machinery of another type will be set up to regulate the industry. If the suggestions contained in agreements submitted early in December to the Oil Administrator are accepted, those small refiners who have been finding it difficult to obtain supplies of crude sufficient for their normal needs will be provided for through a national agency set up to regulate the industry. These agreements, which have been reached and signed by a number of the nation's major oil companies, would limit the crude and gasoline stocks to be carried in the United States. By this means the supply of both crude and refined products would be held reasonably near the demand and allow prices to be governed eventually by the free interplay of economic factors.

Despite the countless difficulties that have had to be overcome in bringing the deliberations on control to their present stage, the oil industry as a whole has undergone rapid improvement in the few short months that the code has been in force. There is every assurance that improvement will continue notwithstanding the violations that have occurred.

Drilling Economics and Oilfield Development

Now that overproduction and its attendant evils are about to be stamped out, petroleum engineers may well direct their attention to the question of sane orderly methods of oilfield development and thus throw further light on the important factors that enter into drilling economics. Perhaps too much attention has been devoted to furthering practices that have hastened the development of new fields and the needless building up of high potential daily rates of production and not enough to the question of applying in actual practice the underlying principles involved in the orderly development of fields, both new and old.

Drilling programs are in too many cases dictated by offset requirements rather than by subsurface reservoir considerations. Such practices have no justification and lead only to what might be considered as a violation of good drilling economics. They eventually lead to economic chaos, particularly when the supply of oil in sight greatly exceeds the normal demand. Even in old fields intensive offset drilling campaigns frequently break out when crude prices increase. Visions of immediate profit, which may only be short-lived, plus a lack of understanding of the vital underground factors that influence the life of the pool, usually tend to distort the judgment of operators. To embark on a drilling campaign necessitated solely by offsetting considerations rather than by reservoir conditions is all too often a gross economic waste and has been directly responsible for many of the ills besetting producers today.

Progress in conducting investigations into the economics of drilling has been hampered in the past by adherence to the law of capture and to the lack of means for controlling the supply to meet the normal demand. With these two obstacles to progress almost out of the way the present is an opportune time to pursue vigorously the field study of this problem. The highly competitive conditions that have prevailed heretofore have destroyed what opportunities there were to acquire the essential information upon which to base a sane drilling program.

A knowledge of reservoir conditions is the starting point for attacking all problems of development, production, and the allocation of production. If it could be determined with some degree of certainty how the oil is distributed in the reservoir and in what amount soon after the pool is discovered most of the inherent difficulties of allocation of production, not only among wells in a pool, but among different pools and different producing districts, will have been practically eliminated. If the engineering phases of the problem can be solved and tangible evidence obtained of reservoir conditions in all parts of the pool, then recourse to uneconomic practices would soon become a thing of the past.

It would seem, therefore, that great good could now be accomplished by concentrating on the technical phases of the drilling problem looking toward the definte elimination of competitive drilling of the destructive type that usually follows the discovery of new fields. This is not only desirable but is imperative if the industry is to be kept on an even keel.

Another Flurry in East Texas

Resourcefulness and cunning are prominent traits of "hot oil" producers in the East Texas field. Recent reports emanating from there are to the effect that illegal production has broken out anew. It appears new methods to escape detection have been devised. Reports have it that prior to the government's order of September 8, tanks were partly filled with water. By draining off this water and replacing it with oil he has been able to run crude that to all appearances was "legally produced." Will this last fling—for such it is—of the "hot oil" runner be brought to a sudden end by federal prosecutors? Let's wait and see.

« « « HIGHLIGHTS IN OILDOM » » »

Offer Premium for East Texas Crude

Competition for crude supplies and well connections in East Texas is at its most aggressive stage. More rigid proration restrictions in other Mid-Continent fields has resulted in attempts by purchasing companies to increase their runs from this field, where approximately 1100 separate operating companies, partnerships and individuals are prospects for well connections. The most prevalent method of gaining new connections is for the crude buyers to pay the producing company the 7½ cents per barrel gathering charge, which amounts to a premium above the posted price of $1.00 per barrel. A decline in East Texas crude stocks of more than 700,000 bbl. during the past month indicates the strength of the demand. The favorable crude market in East Texas is causing operators to continue their extensive drilling campaign and the number of producing wells are constantly increasing at a rapid rate. The per well producing acreage is now below an average of 10 acres per well, but there is no sign of a let-up in drilling.

●

Upholds Oil Ruling

The code of fair competition for the oil industry and regulations promulgated by Administrator Ickes were recently upheld by Justice J. C. Adkins in the District of Columbia supreme court. The suit, filed by Detroit oil dealers, sought to restrain Ickes from prohibiting distributing of coupons redeemable in merchandise.

●

Gasoline Dealers Fined for Code Violations

The government won its first criminal prosecution for violation of an NRA code when two gasoline dealers in Brooklyn, N. Y., were each fined $100 and their corporations were assessed with a $200 fine. At the last minute the two violators changed their plea to guilty and the judge said he lightened the penalty for that reason. Specific charges in the indictment were that the corporations were working their employes 66 hours a week.

●

Greta Operators Want Larger Allowable

Operators in the Greta area, Refugio County, Texas, faced with the probability of a third oil producing horizon and a material expansion in producing limits of the already huge field, have banded together in an effort to gain higher allowable outlets for their wells. The Greta Producers' Association has been organized and argued its cause before the Texas Railroad Commission on December 5. As this is written no definite agreement has been made as to an increase in output.

Working Over Old Leases

The increased price at which crude oil is selling is providing operators of small leases with an incentive to produce more oil. As a result, many old leases are being worked over. Some remarkable results have been obtained on many of them after cleaning out and other necessary operations. This rehabilitation of old leases has necessitated the employment of more men and the purchase of many items of equipment for replacement parts.

●

Production Curtailment More Effective

While the goal has not been reached, the third month of attempted limitation of crude oil production to figures set by the federal agency in Washington finds that much progress has been made. The daily output of the United States has been reduced from 2,748,000 bbl. in August to 2,253,750 bbl. at the close of November. Furthermore, the production curve is continuing downward, giving hope that production may yet be balanced with the indicated demand.

●

Reduced Allowable Set for December

The allowable production of oil in the United States for the month of December was set at 2,210,000 bbl. per day by the federal agency. This compares with an allowable of 2,338,500 bbl. for the months of October and November. The first week of December saw production only slightly above the established allowable.

●

Crude Stocks Decline

Administrator Ickes reports that stocks of domestic and foreign crude oil at the close of November amounted to 341,763,000 bbl., a decrease of 984,000 bbl. from the total for the preceding week, which represents a daily withdrawal of 141,000 barrels. With a further reduced allowable for December it is likely that crude oil withdrawals from storage will be even higher.

●

Motor Car Purchases Increase

The resumption of motor car buying is welcomed by the petroleum industry. November sales of new passenger cars exceeded sales for the same month for the past three years. The 108,000 units sold represented an increase of 145 per cent over November, 1932; 42 per cent higher than November, 1931; and 16 per cent greater than in November, 1930. Motor car sales for the first 11 months of 1933 total almost 500,000 more units than sold during the entire year of 1932. Motor truck sales are likewise increasing; the first 10 months saw 211,600 units sold as compared with 180,400 for the entire year 1932.

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LATEST ACTIVITIES IN THE OIL FIELDS

DEVELOPMENTS in the Greta field, Refugio County, southwestern Gulf Coast district, continue to add to the importance of that area as a producer of crude oil. A test that showed seven fourbles of oil and no water on a five-minute drill stem test is now being completed. Its successful completion will establish a new sand for the pool and extend the producing area nearly one mile south. It is possible that this extension well will result in proving a connection between the Fox and Greta fields. Another extension test drilling in an area heretofore considered doubtful has shown for 30 fourbles of clean oil during a 15-minute drill stem test. It is more than half a mile north of production, and throws an entirely new light on the production possibilities of the field to the north.

●

The encountering of salt water has condemned Humble Oil & Refining Company's efforts to extend the new Long Lake area nearly three miles to the northwest and into Freestone County. Operations were suspended after penetrating the Woodbine sand 122 ft., at which depth salt water put in its appearance with no show of oil or gas.

●

Edge wells in the Government Wells area of Duval County, South Texas, continue to add a little acreage to the already large producing district. Recent discoveries to the north and west of production have just about connected up North Government Wells pool with the Stewart area. The new Eagle Hill field, farther north, continues to yield excellent producers at shallow depths.

●

A large wet gasser has been completed in the Pettus sand of eastern Bee County, South Texas. The well, which had an initial production of 30,000,000 cu. ft. of gas and a spray of oil, is located four miles east and north of the Tuleta field and about the same distance southwest of the Pettus pool.

●

Pure Oil Company has succeeded in extinguishing and in killing its wildcat producer at Louise in Wharton County, Texas Gulf Coast, which had flowed wild for several weeks. Before being killed the well was flowing 1000 bbl. of fluid per day, 50 per cent of which was 42.5 gravity oil. The well is making a lot of gas and registering a very high pressure. After installing equipment adequate to hold the pressure, the well will be cleaned out and screen pipe set before another production test is made.

●

Highlights of recent field work at Livingston, Polk County, Coastal area, have included the failure of a test one mile west of the present limits of the field and the completion in the main part of the pool of one of the best producers yet found. The outpost well is drilling ahead after failing to develop production in the Cockfield formation. The completion in the producing area was good for 432 bbl. of oil the first 16 hours, during which time it was flowing through a quarter-inch choke.

●

Gas flow from the north extension test at Jal, Lea County, New Mexico, has increased to an estimated volume of 100,000,000 cu. ft. daily. It continues to resist successfully all efforts to control the production.

●

In the Crescent pool, Logan County, Oklahoma, tests a few locations northeast and southwest of what appears to be the crest of the structure are encountering dips of such sharpness that it is practically impossible to make straight hole. Some holes have been redrilled several times in an effort to keep them from deviating too far from vertical.

AVERAGE CRUDE OIL PRICES

California	
Playa Del Rey	$ .90
Coalinga	.81
Long Beach	1.00
Signal Hill	1.12
Montana	1.35
Wyoming	1.00
Colorado	1.00
New Mexico	.75
Texas	
North Central	.95
Panhandle	.83
West Texas	.70
Gulf Coast	1.04
Darst Creek	.87
East Texas	1.00
Kansas	1.00
Oklahoma	1.00
Arkansas	$ .70
Louisiana	
North Louisiana	.95
Gulf Coast	1.04
Illinois	1.22
Kentucky	1.17
Indiana	1.22
Ohio	
Lima	1.30
Wooster	1.15
Michigan	1.02
Pennsylvania	
Bradford	2.45
Southwest	2.12
Corning	1.20
West Virginia	2.07
Canada	2.10

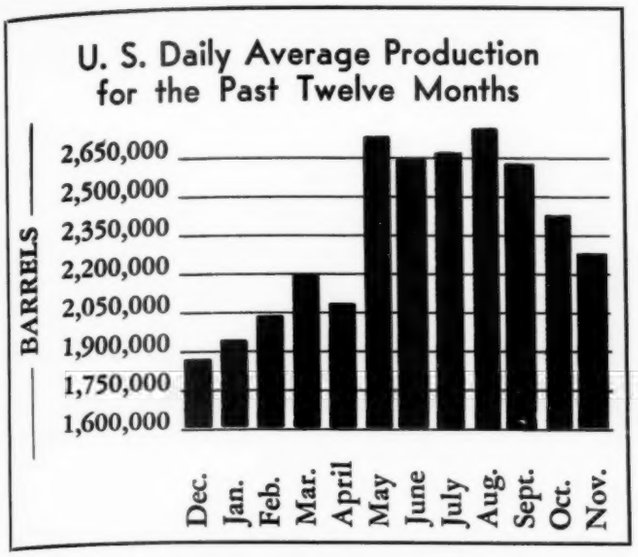
DAILY AVERAGE CRUDE OIL PRODUCTION

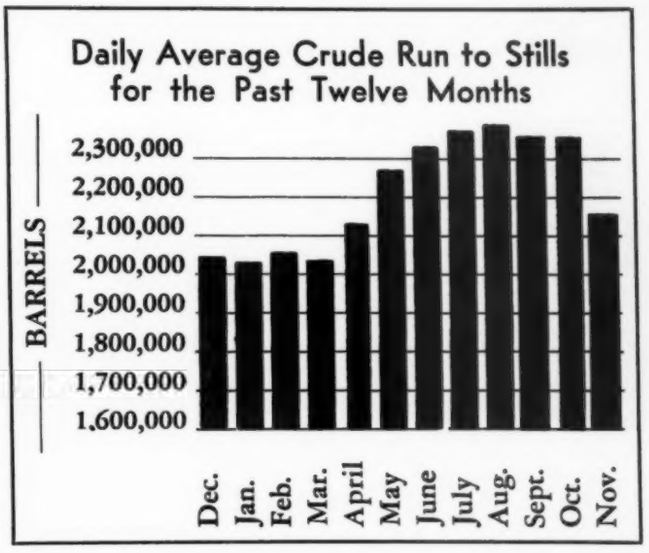
(Figures in Barrels)

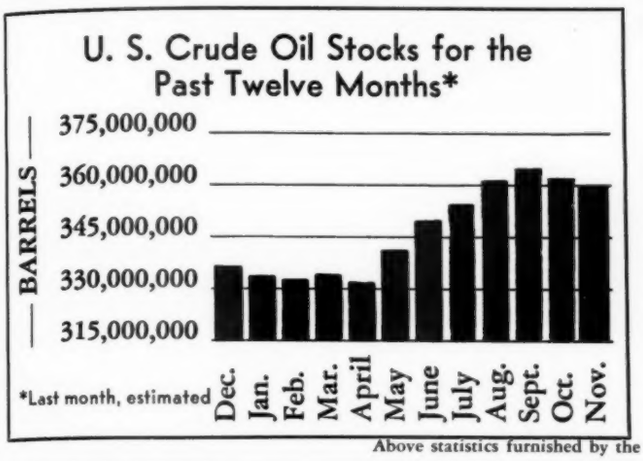
Furnished by A.P.I.

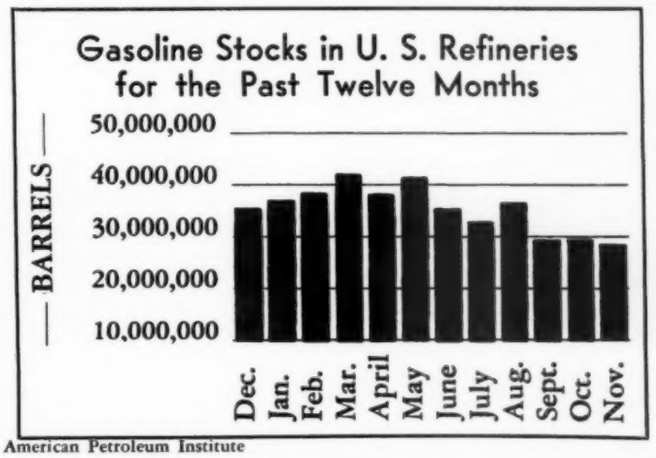
	Federal Allowable Effective Oct. 1	W'K Ended Nov. 25 1933	W'K Ended Oct. 28 1933	W'K Ended Nov. 26 1932
Oklahoma	495,000	497,750	471,050	366,800
Kansas	116,000	116,300	111,750	102,200
Panhandle Texas		40,350	45,200	45,450
North Texas		57,300	53,300	47,850
West Central Texas		24,100	23,400	24,750
West Texas		121,700	122,000	165,150
East Central Texas		43,500	44,400	49,300
East Texas		349,250	464,600	360,000
Conroe		55,650	73,650	16,200
Southwest Texas		43,300	47,850	53,300
Coastal Texas (Not incl. Conroe)		98,600	112,250	107,650
TOTAL TEXAS	965,000	878,750	986,650	869,650
North Louisiana		26,200	26,250	28,900
Coastal Louisiana		47,450	48,200	34,800
TOTAL LOUISIANA	70,000	73,650	74,450	63,700
Arkansas	33,000	33,300	32,850	34,050
Eastern (Not incl. Michigan)	94,200	95,150	96,450	96,800
Michigan	30,000	32,050	29,800	19,250
Wyoming	30,050	29,700	29,850	34,600
Montana	6,450	7,200	6,700	6,400
Colorado	2,400	2,450	2,450	2,750
New Mexico	41,400	42,150	41,950	31,450
California	455,000	44,300	474,200	471,600
TOTAL	2,338,500	2,253,750	2,358,150	2,099,250

[1]Production figures furnished by the American Petroleum Institute.









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for November, 1933

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	338	335	262	63	149	3600	2	40	Rotary
Duval County	36	31	29	7	29	2300	2	22	Rotary
Conroe	34	33	18	10	46	5200	2	38	Rotary
Refugio County	19	16	13	6	34	3000–7400	3 or 4	40	Rotary
Oklahoma									
Oklahoma City	10	8	6	17	33	6500	3	39	Rotary
Kansas									
McPherson County	17	12	15	4	30	2900–4300	2	38	Rot-Cab.
Ellsworth Arch	17	17	12	9	28	3300	4	37	Cable
Harvey County	8	6	2	4	22	3450	2 or 4	37	Rot-Cab.
California									
Kettleman Hills	3	3	2	5	20	8300	3 or 4	40	Rotary
Long Beach	1	1	3	6	21	7000	3	26	Rotary

Field Activities by States for November, 1933

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1932 (In Barrels)
	November	October	November	October	November	October	November	October	November	October	
Arkansas	0	3	0	0	5	3	15	8	29	28	11,907,000
California	27	46	26	45	34	35	46	41	159	130	178,128,000
Colorado	6	2	4	0	....	....	5	6	51	51	1,177,000
Illinois	0	0	0	0	....	....	1	1	13	12	4,661,000
Indiana	22	25	13	18	....	....	1	1	38	46	804,000
Kansas	68	71	56	57	48	74	25	35	125	108	34,300,000
Kentucky	19	16	6	10	....	....	2	2	53	51	6,264,000
Louisiana	43	63	21	36	64	72	72	54	130	157	21,478,000
Michigan	44	43	33	37	35	47	109	105	124	137	6,729,000
Mississippi	3	8	1	4	....	....	10	11	15	19	Gas Prod.
Montana	11	5	10	4	....	....	9	3	46	38	2,449,000
New Mexico	3	5	3	4	....	....	2	5	53	56	12,511,000
New York	0	4	0	1	....	....	1	1	16	18	3,501,000
Ohio	74	106	57	57	....	....	33	35	136	137	4,597,000
Oklahoma	126	133	79	88	150	171	95	88	302	308	151,621,000
Pennsylvania	205	43	150	36	....	....	21	28	98	137	12,403,000
Texas	711	840	576	674	630	831	257	214	887	823	311,069,000
West Virginia	31	26	28	21	....	....	23	26	53	68	4,472,000
Wyoming	7	9	3	4	....	....	5	8	67	69	12,359,000
Total	1400	1448	1066	1096	966	1233	732	631	2395	2263	781,845,000

PROGRESS OF MAJOR PIPE LINE WORK

By WARREN L. BAKER

FORTY miles of 10-in. pipe is being laid from a point near Ainsworth, Iowa, to Cedar Rapids, Iowa, by the United Light and Power Engineering and Construction Company of Chicago, Ill. At Ainsworth the line will connect with the Natural Gas Pipeline Company of America's main line from the Texas Panhandle. At Cedar Rapids the new transmission system will be tied in with the Cedar Rapids Gas Company's distributing system.

Work on this pipe line was commenced during the latter part of November and, it is expected, will be completed around January 1, 1934. E. L. Fischer, gas engineer, is in charge of construction for the United Light and Power Engineering and Construction Company. A regulating and measurement station will be built at Cedar Rapids.

●

Pan-American Pipe Line Company, subsidiary of the Standard Oil Company of Indiana, is erecting additional equipment, which will double the pumping capacity of the four main line stations on the combination 8-in. and 10-in. trunk line operated from Mexia, Texas, to Houston, Texas. The company completed, last September, an extension line from Houston to Texas City, where the Pan-American Refining Corporation is building a modern refinery. The enlargement of the pumping capacity on the Mexia-Houston division will probably be followed by the laying of additional loops, giving the line a capacity of around 60,000 bbl. daily. Stations to be enlarged are Bullock, near Mexia; Easterly, Singleton and Hufsmith.

●

Natural gas will be available to consumers in Phoenix, Arizona, not later than the first week of January. At that time Western Gas Company's 216-mile 10-in. line from Douglas, Arizona, via Tucson, to Phoenix will be completed.

●

According to reports, Sunbright Pipe Line Company, Sunbright, Tenn., has contracted for 80 miles of 10-in. pipe for a line to run east from the Sunbright fields. As planned, the line would split at Wartburg, one branch going to Harriman and Rockwood, the other through Clinton and possibly to Knoxville. The Sunbright Pipe Line Company is a subsidiary of the Public Service Corporation of Tennessee, of which J. H. Graham is president. Public Service Corporation holds leases on more than 100,000 acres of proven, semi-proven and wildcat acreage in Morgan County, Tenn., where the proposed line would originate.

●

Recent interest in the pipe line industry has been centered in Western Kansas, which area is being supplied with transportation facilities by several lines now under construction. It is understood that White Eagle Oil Corporation will soon start work on a pipe line extending into Rice County, which may be projected northwest into Russell County. The line would reach from the company's present terminal in the Hollow field of Harvey County to the Chase townsite area. According to the plan, an 8-in. line would be laid just south of Lyons and to the east side of the Chase townsite field, from which point a 6-in. line would extend into the Chase field and another would be built to the southwest to connect with the Sharpe pool.

It is reported that the company is also contemplating the extension of this newly-proposed system to include a 6-in. line to the Isern pool in Barton County, while still another would tap the Schurr field north of Raymond. It is also possible that the company will extend its proposed Western Kansas system to include the Orth and Holyrod fields and thence into Russell County.

●

The Sinclair-Prairie Pipe Line Company is doubling the capacity of its pumping plant in the Schurr field north of Raymond, in Rice County, Western Kansas. There is so much oil moving through this line from the fields in Stafford, Ellsworth, Rice and Barton counties that a new station is needed to help carry the pumping burden. This enlarged capacity will assure a greater supply of crude to move from the Western Kansas areas to refineries in the eastern part of the state.

●

According to an announcement by Harry E. Littig, general manager of the Peoples Light Company, a 14-year contract has been signed with the Natural Gas Pipeline Company of America, under which the latter company will supply gas from its Texas-Chicago line to Davenport, Iowa. Gas probably will be available in Davenport by January 1, 1934. A 6-mile, 8-in. lateral, pipe for which has been ordered from the Republic Steel Corporation, is to be laid by the Peoples Light Company. A governing and metering station will be built at Blackhawk, Iowa, which will take gas from the pipe line company at a minimum pressure of 225 pounds.

THE MONTH'S ACTIVITIES IN REFINING

By F. R. STALEY

Per Cent Refining Capacity Operated

Eastern Division, 72.0 Per Cent **Central Division, 65.5 Per Cent** **Western Division, 51.2 Per Cent**

AN increase in natural gasoline plant construction work was a feature of the past month. A number of large gasoline plants in widely separated areas of the country are now being built.

●

Humble Oil & Refining Company is constructing a natural gasoline plant in the Conroe, Texas, field to treat 12,500,000 cubic feet of gas daily. This, it is expected, will recover around 10,000 to 12,000 gallons of stabilized natural gasoline daily. The plant will be a combination compression-absorption installation. In the same field, Midland Gasoline Corporation plans to increase its capacity materially. When the new construction work is completed on the Midland plant it will have a capacity of 28,000,000 feet daily. The new works includes absorption and distillation units with heat exchangers, preheater and condensing units. The design and equipment were furnished by Petroleum Engineering, Inc., associated with Arthur G. McKee & Company.

●

The Texas Company has commenced work on a 10,000,000-cu. ft. natural gasoline plant on the western edge of Foard County in the Wichita Falls, Texas, district. Construction is being hastened so that the plant may be in operation by February 1, 1934. This is the first natural gasoline plant to be built in Foard County.

●

The Agua Dulce field in Nueces County, Texas, will soon have a 30,000,000-cu. ft. gasoline plant. It is being constructed by Garland Clymore of the Clymore Company, now operating a similar plant in the Refugio field.

●

O. C. Field Gasoline Corporation is constructing at Huntington Beach, Calif., a third natural gasoline plant. It will have a capacity of 30,000,000 cu. ft. per day. The other two Field plants have a combined capacity of 20,000,000 cu. feet.

●

The Associated Oil Company of California has drafted plans for spending a million dollars in improvements at its Avon and Watson refineries, according to announcements. This expenditure will be in addition to that previously announced for spending $6,000,000 on the company's plants. It is understood that work will get under way immediately.

●

The Southport Refining Company, operators of a 1500-bbl. skimming plant at Kilgore, in the East Texas field, has let contracts for the erection of a 1500-bbl. cracking unit. The contract was awarded the Mid-Continent Engineering Company. The new unit is designed to crack reduced crude daily, stocks of which have been accumulated over a long period of time.

●

The Security Petroleum Company has selected the site for its 3000-bbl. refinery in the Chase townsite field of Rice County, Kansas. It will be just south of the Chase city limits. Materials are now being shipped in for this plant.

●

Pierce Petroleum Corporation, Tampico, Mexico, is reconstructing its refinery at Tampico, Mexico, recently damaged by a hurricane. The estimated cost of the reconstruction will exceed $100,000.

●

Apex Construction Company of Houston has a contract to lay various pipe lines necessary to connect the Pan-American Refining Company's plant at Texas City with the loading docks now under construction. Although the refinery and docks are less than a mile apart, approximately 13½ miles of pipe will be required.

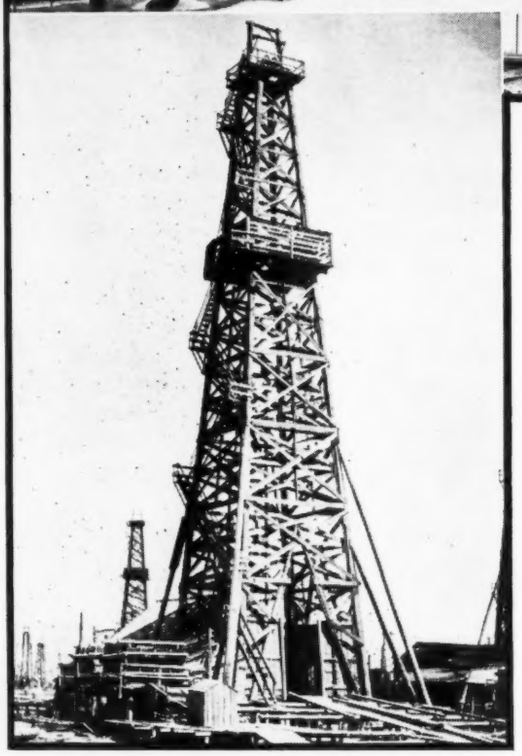
Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 25, 1933

A.I.P. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.00	452,000	77.7	14,154	8,213
Appalachian	92.6	94,000	67.3	2,169	1,005
Ind., Ill., Ky.	97.3	302,000	71.1	7,075	6,106
Okla., Kans., Mo.	82.1	221,000	58.2	5,601	4,224
Inland Texas	60.2	92,000	55.7	1,307	1,755
Texas Gulf	98.1	433,000	82.1	5,009	7,219
Louisiana Gulf	100.0	105,000	64.8	1,373	1,999
No. La.-Ark.	92.6	51,000	66.7	235	570
Rocky Mountain	78.8	32,000	50.3	868	724
California	96.9	428,000	52.1	14,138	94,503
TOTALS WEEK:					
November 25, 1933	92.4	2,210,000	66.1	51,934	126,318
November 18, 1933	92.4	2,196,000	65.7	52,102	127,528

Above—A view in one of the older areas, the Balakhany field. A large portion of the area pictured was filled in



A modern rotary rig for drilling to depths of about 4500 ft. in the Bibi-Eibat field

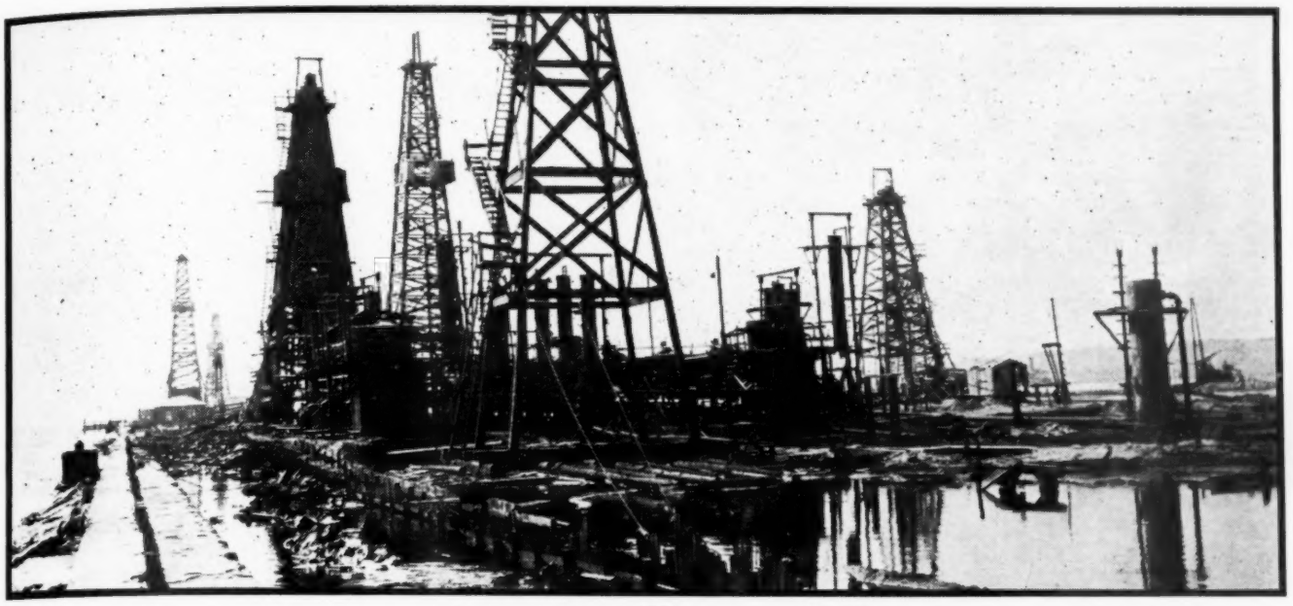
Recent Oil Developments

THE Russian petroleum industry, second only in importance to that of the United States, has been undergoing rapid development during the last few years, and promises to assume even greater proportions in the near future. Intensive exploitation of her older producing areas, coupled with hasty development of a number of recently discovered fields, promises to carry Russia's rate of crude production to a new high level. Though most of this new supply will be needed in providing petroleum products for her rapidly expanding domestic industries, an increasing amount will doubtless find outlet in foreign commerce. Petroleum products comprise the Soviet Government's principal "meal ticket" in international trade: the means by which are financed extensive purchases of machinery and supplies that Russian industries are not yet able to produce.

There has been a phenomenal expansion of the so-called "heavy industries" in Russia during the last few years. Many new manufacturing industries have been created. Probably in no other country in the world has more new construction been undertaken in so short a time. Agriculture has been mechanized: thousands of small and independent farms previously using primitive equipment have been "collectivized" and are being operated in large units with mechanical equipment. The transportation industries have likewise been rapidly expanding, particularly in the automotive field. All of this has necessitated a substantial increase in the supply of petroleum products. This domestic industrial expansion is a continuing one: at least during the period of the second five-year plan, and will require important new supplies of petroleum products during the next few years.

Recently, Soviet oil products have found their way in increasing amounts into channels of international commerce. Large contracts have been made for the delivery of petroleum products from Russian refineries in various countries where the marketing of oil products is regulated by government monopoly. Soviet oil sales organizations have also been organized to promote trade in oil products abroad and are securing an increasing business. This foreign trade in petroleum products promises further expansion, particularly in view of the low production cost of Russia's crude and its proximity to eastern and central European markets.

Organization. Like all other large-scale enterprises in Russia, the petroleum industry is organized as a government monopoly. Control of the industry is vested in a number of trusts charged with the conduct of different phases of it and with different regional subdivisions. All these are, in effect, subdivisions of "Glavneft," the central petroleum industry organization having headquarters at Moscow. Thus, we find the "Azneft" trust in immediate charge of all oil industry operations in the Baku region, while the "Grozneft" organization is in control of that of the Grozny region. The "Maineft" trust operates in the Maikop district. "Neftezavodi" operates refineries in the central district. "Neftetorg" is the domestic



Reclaimed land behind the sea-wall, Bibi-Eibat field, near Baku, U.S.S.R.

Industry in the U. S. S. R.

By LESTER C. UREN
Professor of Petroleum Engineering
University of California

marketing organization. "Nefte-export" is in charge of the entire foreign exporting business. "Nefteprojekt" is the central designing and planning bureau, dealing particularly with refinery operations. "Chimgas" is concerned with the development of chemical industries using refinery and natural gases as raw materials. The Gini, Grozny and Baku research institutes also have an active part in the development of new processes and equipment for the petroleum industry. There is likewise a close liaison between the active producing, refining and research organizations and the petroleum technology institutes at Grozny and Baku, where large groups of students are receiving university grade technical preparation for future employment in various divisions of the Russian petroleum industry.

Exploration. Geologic reconnaissance and exploration for new petroleum resources is conducted by highly trained geologists and geophysicists using the most modern methods. The work done in this division of the industry, will compare favorably with that done by the best of our American oil-company geological staffs. Indeed, an impartial observer might be led to conclude that Russian technologists are leading in the development of certain lines of exploration technic. Many geologic survey parties are in the field in various parts of Russia, and much detailed areal and structural surveying is being done in the more promising regions. As an immediate result of this activity, numerous prospective areas have been found and test drilling has disclosed the presence of oil in many cases. Particularly profitable geological work has been done in the Baku region, where a half-dozen or more new fields have been proven and are now in the early stages of development. These new fields are of particular interest geologically, in that they are immediately associated with very large active mud volcanoes which present unusual structural and tectonic features. Many of these mud volcanoes have been mapped in the field, but comparatively few have yet been tested with the drill.

Classification of micro-fauna has been found to afford a valuable means of correlation, particularly in the Baku region. Globigerina are useful in this connection as well as foraminifera. It has been found possible to collect suitable specimens for identification from rotary mud fluid, thus obviating the necessity of coring. Mineral grain studies have also shown a half-dozen or more of the less common heavy minerals to be useful markers for different stratigraphic horizons. Ground water analyses also furnish a useful guide for correlation purposes, and in estimating the proximity of oil-bearing sediments. Sulphates characteristically disappear in the ground waters, as the oil measures are approached. The technic of this microscopic, lithologic and chemical inspection work has been developed in the central research laboratories, particularly at Baku, but is now conducted in many small field laboratories in the immediate vicinity of the drilling wells.

Geophysical methods have been extensively used by Russian geologists as a guide in interpreting structure. Both gravitational and magnetic methods have been employed, but the electrical methods have been found most helpful. The Schlumberger method of electrical coring is extensively used, and resistivity and porosity profiles as recorded by the Schlumberger apparatus, are assembled and preserved for each well drilled. In most instances this record is found to provide a useful index of the oil and gas producing characteristics of the formations penetrated. A novel and interesting application of the Schlumberger apparatus has also been found in off-shore studies of oil-bearing structures beneath the waters of the Caspian sea. It has been found possible to map the position of a limestone marker stratum at distances up to six kilometers off shore. The waters in this region are shallow (less than 20 ft.) and it is probable that a number of struc-

tures defined by this means will soon be tested with the drill. Like structures on shore have been found to be productive, and there seems to be no reason why those beneath the bed of the sea should not be likewise.

Detailed geological studies of prospective areas are frequently assisted by the drilling of shallow test wells exclusively for structural information. Light portable drilling outfits are used for this purpose. Airplane mapping of prospective territory is also practiced to some extent, particularly in areas where topographic maps are not available. Structures are often so well marked at the surface as to justify the term "text-book geology," frequently applied to the physiography of this regian.

The producing horizons in the principal oil fields of the Grozny and Baku regions are Lower Pliocene and Upper Miocene in age, and age classification of sediments in the prospective areas by palacontological methods plays no small part in successful field reconnaissance.

Development. Government ownership and operation of all oil fields permits complete exercise of modern principles of petroleum engineering under unit control. Since there are no property lines or lease obligations, each structure is developed in accordance with the best judgment of the technologists in charge. Much attention has recently been given by engineers and geologists entrusted with the planning of development programs in the various proven areas, to the problems of well spacing, sequence of drilling and arrangement of wells for most efficient drainage and economic results. The development program adopted depends, first of all, upon the dominating force thought to be operative in expelling the oil from the reservoir rock. Where pressure is maintained in the producing formation by advancing edge-water as oil is withdrawn, a development program may be adopted quite different from that in fields where the edge-water does not encroach rapidly enough to maintain hydrostatic pressure on the oil and expanding gas is the dominating expulsive force. Apparently in different parts of some fields, both controls are operative, and the development programs become more complex.

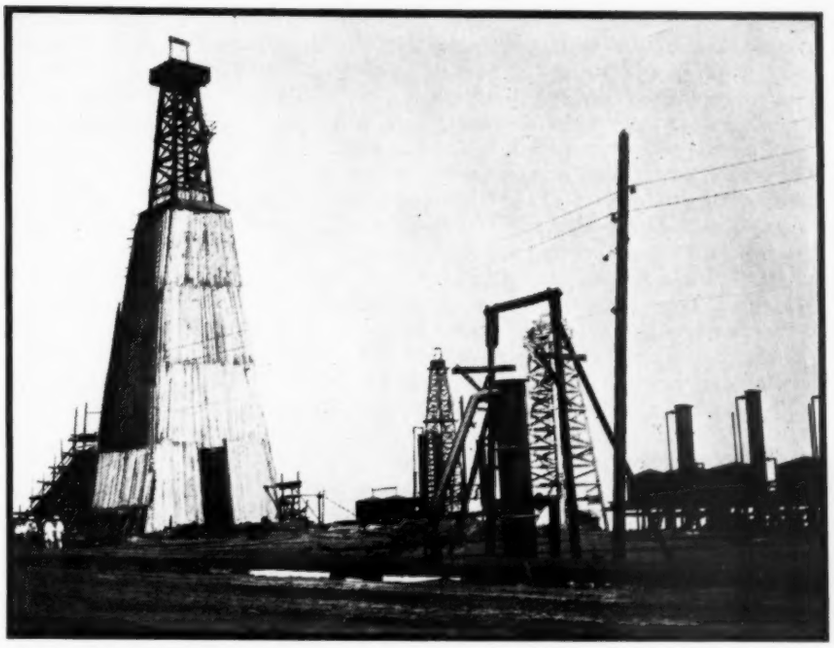
Development programs in most of the Russian fields are also complicated by the fact that the structures are often faulted in such a way that different portions of the field must be treated as separate producing areas. Furthermore, the oil generally occurs in multi-zone deposits, each zone in reality constituting a separate reservoir. In some cases there are as many as 16 well-defined producing zones, one below another, separated by thick and apparently continuous shale bodies. Edge-water lines in the different producing zones must be carefully watched, otherwise there is danger, where more than one zone is producing in a single well, of edge-water in one zone flooding out other sands that are still productive. Seldom is it feasible to produce from more than two or three zones simultaneously in any one well, and consequently several series of wells must be drilled, each attaining a different stratigraphic depth, if the full thickness of the producing formation is to be exploited simultaneously. The lower zones are characteristically narrower in areal expanse, and have steeper dips than the shallower producing horizons.

RECOGNITION of the Soviet Government by the United States last month renders the observations in this and succeeding articles by Professor Uren of timely interest. Because of her vast potential oil resources, now under systematic and modern exploitation, Russia looms as a powerful factor in the oil affairs of the world, not only as a producer of oil but also as a consumer of petroleum products and equipment. The author, a keen student of progress in all technical and practical phases of the oil industry, who returned from a visit to Russia only a few months ago, presents his constructive observations during that visit and conveys a clear picture of present and probable future developments of the oil industry in U.S.S.R.

Earlier development practice has been along orthodox lines of drilling the earlier wells in each producing area to the shallower sands, and then developing the deeper zones in turn, either by drilling new sets of wells, or deepening the earlier wells, as production requirements might dictate. Recent engineering and economic studies, however, have led to the adoption of the opposite plan of developing the producing formation "from bottom to top." Under this plan, the deepest known producing zone in each area is taken as the objective for all the early wells drilled. With no earlier depletion of the upper zones, it is possible to drill through them without danger of drilling fluid entering: a tendency that causes no little difficulty when wells to deeper zones must be drilled through partially drained upper zones. In drilling through the upper zones, electrical coring or actual core samples give complete information of their lithologic character and oil- and gas-yielding potentialities. Later wells drilled in the development of the shallower upper zones may thus be located and drilled with full information of subsurface conditions. If an early well drilled to the lowermost producing horizon finds that zone non-productive, it may be plugged back to produce from one of the shallower upper zones. It is claimed that this system of development affords maximum early subsurface information, and results in the drilling of a minimum number of dry holes. Also — and this is an important consideration, in view of the dictates of the ambitious second five-year plan — the new development program permits of early substantial production from the more prolific lower zones.

Careful study has been made of the several possible systems of determining the sequence of drilling of the wells and their location with respect to structure, edge-water lines and gas-cap. In instances where pressure within the formation is maintained by advancing edge-water, it is regarded as an unnecessary expenditure of capital to drill in the vicinity of the edge-water lines. Primary gas-caps are thought to be rare in the Grozny and Baku region producing zones; the oils are in most instances found to be less than saturated at the existing formation pressure: hence, there is no reluctance to drill on the crest of the structure. Where primary gas-caps are known to exist, however, no wells are drilled on the crest, and a program of retreating from the edge of the gas-cap to the edge-water line is followed in the drilling of wells. Within areas available for drilling, three possible systems are recognized in determining the sequence of drilling. Simultaneous development of the entire area is regarded as most efficient, where expanding gas is the controlling expulsive force, in securing the advantages of maximum initial field pressure for every well. Because of the large investment in drilling equipment required by this system, however, it is regarded as impractical except in the development of small areas where but a few wells are to be drilled. Other possible systems are the "creeping systm," in which wells are drilled in rows extending outward from an initial center; and the "condensing system," in which later wells are drilled between a grid of widely-spaced early wells. Of these two latter-named systems, the "creeping system" is regarded as most efficient.

Rotary methods of drilling are exclusively used. Formerly



A sheathed rig on a high-pressure well in the Bibi-Eibat (Stalin) field

the Galician (rod tool) rigs were chiefly employed, but none is to be seen in use today in the Grozny and Baku regions. Cable tools seem to be unknown among Russian drillers, but would probably not be so satisfactory as rotary equipment for drilling in the soft, semi-consolidated formations that overlie the oil-bearing formations. Most of the rotary rigs in use are patterned closely after modern American-made equipment, though now manufactured in Russia. The writer has inspected a modern, heavy-duty rotary rig with four-speed draw-works, every part of which was Russian made. Casing and drill pipe are also manufactured in Russian tube mills. Timber is universally employed in derrick construction. Electric power is preferred for drilling, and is available in the older fields. Where not available, oil engines of semi-Diesel type are used. Steam equipment is unusual. The chief departure from American rotary drilling practice is the use of a four-man crew instead of five. Another noticeable difference is the general use of one mud-pump instead of two.

A unique feature of Russian drilling practice is also found in the development and frequent use of the turbo-drill, which is mounted on the lower end of a non-rotating drill pipe, the drill being rotated by a turbine actuated by the circulating mud fluid. The turbo-drill mechanism has recently been redesigned to procure greater mechanical efficiency and suitable speed reduction, and new patterns are said to overcome most of the difficulties experienced with the earlier models. Apparently the only difficulty now experienced is that of sand scouring on the stationary rotor guides, and it is believed that this can be overcome by proper elimination of sand from the circulating fluid. A large plant with modern shop equipment is engaged in the manufacture of turbo-drills in the Surakhany field, near Baku. Each drill is given a thorough test under conditions comparable with those to which it is subjected in the well, before leaving the manufacturing plant. The turbo-drill apparently possesses certain definite advantages, in comparison with the ordinary rotary equipment, including greater efficiency in power application, fewer twist-offs and less destructive vibration and fatigue on the drill pipe and surface equipment. Bit pressure can also be more accurately controlled. Extensive use of the turbo-drill in the Russian fields is planned for the near future, particularly in drilling to the deeper horizons, where its advantages become more apparent.

The depths to which wells have thus far been drilled in the Russian fields would be characterized as shallow in terms of present-day American deep-drilling practice. Thus far, it has seldom been necessary to drill to greater depths than 4000 or 4500 feet. Some very difficult drilling problems have been encountered, however, particularly in the control of abnormally high gas pressures and heaving shales and sands from the oil-bearing formations. Gas pressures of from 1200 to 1600 lb. at depths of 1500 to 3000 ft. lead to disastrous blow-outs and loss of control of wells at critical times, often accompanied by influx of great quantities of shale and oil sand. In some cases, even though pressure control is maintained at the surface, unconsolidated material flows into the well as rapidly as it is removed, so that little or no progress is made. Use of heavy minerals in the circulating fluid and careful control of the properties of the fluid to avoid gas-cutting, offer promise of some improvement, but it will probably be found necessary to resort to pressure drilling to contend with conditions presented in some of the more troublesome areas.

Special attention has been given in high-pressure areas to the preparation of suitable mud fluids of high density and proper viscosity. Barite, Hematite and Siderite have been employed, together with highly colloidal clays comparable with the American product, Aquagel. In some cases, stable fluids having a density substantially twice that of water have been developed. Special studies have been made of the sand-settling characteristics of different styles of mud ditches and a shallow rectangular launder with enlarged rectangular settling boxes in the circuit has been adopted as a standard. In high-pressure areas, a mechanical mud-mixer is provided at the well, with two large rectangular timber tanks for storage of reserve heavy fluid. Central mud-mixing plants with pipe line distributing systems are planned for some of the recently proven areas where considerable drilling is to be done.

Usual casing practice involves landing a column of pipe in the cap-rock immediately above the zone from which it is desired to produce. This is cemented, sufficient cement being used to fill the space about the pipe to a point above the capping of any over-lying producing or potentially producing horizons that may have been penetrated. If the oil producing formation is semi-consolidated or unconsolidated, as is usually the case, a shop-perforated liner is placed in the well opposite the oil sand. Neither screen pipe nor slotted pipe is used, though many difficulties in production practice result from sand influx.

Production. The Russian oil fields of the Baku and Grozny regions are among the most prolific in the world and very high per-well and per-acre yields are obtained. The oil sands are thick and unusually porous and permeable. Initial productions of wells from some of the deeper zones now being exploited are commonly from 1000 to 10,000 bbl. per day, and in some cases productions as great as 50,000 to 100,000 bbl. per day have been indicated. One well in Lok Batan, one of the recently discovered fields near Baku, produced 250,000 tons of oil in 13 days. At times it was estimated to be producing at the rate of 25,000 tons (170,000 bbl.) per day. Control of the well was lost when it blew in, and never regained during its 13 days of productivity, at the end of which time it became clogged with sand. Many acres of terrain about the well were buried under several feet of oil sand

brought to the surface with the oil. The well was drilled on the flank of an active mud volcano. Many additional wells have since been drilled in the vicinity of this gusher and are said to be averaging upwards of 500 tons (3,500 bbl.) per day. The Puta field, a few kilometers distant, is also developing gusher production, and at least four other structures of like character in this same region now being tested offer promise of production of like character.

Even some of the older fields that have been actively exploited for 30 years or more are still yielding large quantities of oil. The old Bibi Eibat (Stalin) field, for example, is developing a large supply of gas and large flowing wells from deeper zones only recently discovered and from extensions of the oil field on areas reclaimed from the Caspian sea. A large area of new land on which wells are being drilled has been added to the Bibi Eibat field by dredging sand behind a substantial sea-wall. Additional reclamation work of this same character is planned, and in addition, wells are to be drilled on artificial "islands" to be constructed on off-shore locations. One such "island well" has already been completed and is now producing. A large and highly prolific area has also been added to the Balakhany field by filling in a shallow lake, formerly an arm of the Caspian sea.

Most of the wells in the Baku and Grozny fields flow for a time when first completed. Present practice is to operate them by gas-lift when they no longer flow naturally, but eventually, as fluid levels subside, they must be mechanically pumped. Large and well-designed central compressor plants furnish compressed air or gas for gas-lift operation. In the Bibi Eibat field one high-pressure gas well producing from a deep gas sand is producing, without necessity for compression, much of the gas that is needed for gas-lifting oil from overlying zones. Pumps of D & B or Axelson type are generally used, though Fluid-Packed and various patterns of insert pumps are used under special circumstances. An unusual style of tubeless pump in which a working barrel is supported in a packer anchored in the lower end of the well casing is used to some extent. No tubing is required, production reaching the surface through the casing. The Fettke long-stroke pumping equipment is frequently met with, as well as Lufkin and various other types of geared pumping units, most of which are closely patterned after American production equipment, though now manufactured in Russia. Multiple pumping with modern band-wheel powers is met with in the shallower territory, where well equipment, repair and clean-out jobs are not of too frequent occurrence. Electric power is almost universally used for plunger-pumping. Portable well-pulling equipment, mounted on tractors or motor trucks, is frequently employed in well equipment repair.

An important problem in most of the fields in the Grozny and Baku regions is that of sand incursion. Sand produced with the oil rapidly destroys valves, fittings and flow beans in flowing and gas-lift wells and destroys pump valves, plungers and liners in pumping wells. The necessity for handling large quantities of sand with the oil also complicates the problem of gas trapping, particularly where high-pressure gas trapping is necessary. The oil sands are medium to fine grained, sub-angular or well rounded and quite uniform in size and texture. Much of the sand that enters the wells with the oil could be restained by the use of screen or slotted pipe, as experimental and field tests have shown, but prevailing opinion seems to be opposed to this practice, apparently on the ground that it would restrict production. There is good reason, both in theory and field production records, for the belief that removal of some of the oil sand with the oil, thus forming cavities about the wells within the reservoir rock, promotes recovery efficiency. It seems quite probable that the prolific yields and apparently high percentage recovery of oil obtained in the unconsolidated sand fields is due to this practice of permitting influx of sand into the wells. The most phenomenal producers, such as that of the big producer in the Lok Batan field, cited above, are those that produce great quantities of sand along with the oil. It may well be that American producers have something to learn from Russian practice in this regard.

Russian practice suffers in comparison with that of American producers in the matter of production records. Perhaps this is partly due to the absence of any necessity for accounting to royalty owners. At any rate, few gas meters are in evidence and it is unusual to find tankage and facilities available for gauging the oil production of individual wells. Continuous well-head pressure records are unusual and bottom-hole pressure tests are as yet unknown. Water production records are of doubtful dependability. Lack of suitable individual well records makes difficult the problem of engineering analysis and control of production, and this constitutes — in the opinion of the writer — one of the principal opportunities for improvement in existing practice.

In most of the producing horizons of the Baku and Grozny oil fields the wells produce with unusually low gas-oil ratios: often but a few hundred cu. ft. per barrel. Considering the abnormally high formation pressures, it is apparent that the oil as it exists in the formation is not fully saturated. The small proportion of gas produced with the oil and the well-sustained production of the wells indicates that edge-water pressure is in some cases at least, the dominating expulsive force. However, in other cases, the wells exhibit decline characteristics suggestive of a declining field pressure in which expanding gas is the dominating expulsive force. That encroaching edge-water often plays an important rôle in influencing displacement of oil from the reservoir rock is apparent on consideration of the rapidity with which the percentage of water increases in edge wells as production proceeds. Another factor suggestive of the influence of edge-water as an expulsive agent is the unusually high percentage ultimate recoveries that are apparently being procured. Recoveries of the order of 50 per cent, or even more in some instances, such as are indicated on the basis of computations of available storage space within the reservoir rock, are possible only where water-flooding has been operative.

Emulsification of the oil is troublesome in some fields, particularly in the Grozny region. Dehydration is accomplished by heat-treatment methods that result in excessive losses in evaporation and unresolved emulsion. Losses are said to be as high as seven per cent in some cases.

Though varying somewhat in different regions, the oils produced in successive zones in the same locality, are surprisingly uniform in character. Much of the Baku and Grozny oil is about 0.85 to 0.87 in specific gravity. That produced in the Grozny region yields both paraffin and asphaltic products, but the Baku oils are definitely naphthenic in character. The oils yield a substantial percentage of naphtha by straight-run distillation but both the yield and quality of the motor fuels are improved by cracking.

Secondary methods of stimulating recovery are being successfully used in some of the older fields where percentage recoveries have been low and production has declined to low levels. The Marietta process, involving injection of gas into the partially drained horizons is being successfully practiced in one portion of the Grozny field, and other applications of this process are contemplated for the near future. Plans have also been prepared for development of an oil mining enterprise in one of the shallower zones of the old Grozny field. Shaft-sinking may begin within a year, if the plans developed by the engineers in charge are approved. Field-scale experiments with artificial water-flooding are also contemplated.

Personnel Activities. No record of oil industry activities in Russia would be complete without some mention of the efforts that are being made to improve the working and living conditions and educational facilities provided for the oil field workers. The working day is eight hours and every sixth day is a holiday. There is one month's vacation with pay in each

year. Workers receive from 200 to as much as 800 rubles per month, depending upon their educational status, position and the character of work performed. Many new and modern apartments, dormitories and two- or three-family cottages have been built during recent years in the principal oil field centers for the housing of oil industry workers. In the larger cities, such as Grozny and Baku, large and well-appointed community buildings have been erected to serve as recreational and educational centers. "Factory kitchens" provide large-scale facilities for food preparation and distribution. The writer's observation leads him to the belief that oil industry workers in Russia as a group are comparatively well-fed and housed, more so, for example, than people living in the agricultural regions. Under the Soviet system of government, workers are given free medical attention, hospital and clinical facilities. They are promised some degree of protection in the matter of accident, sickness and old-age insurance.

One of the most commendable features of Soviet rule as applied to the oil industry, is the effort to improve the general educational level of the workers. Starting after the revolution, with a high percentage of illiteracy, this has been rapidly reduced until now, only a small percentage are unable to read and write. Workers are also given systematic vocational training designed to improve their efficiency and occupational status. For those who wish to progress beyond the general educational level afforded by the common schools, there are well-organized petroleum technology institutes and universities. More than 2000 are enrolled as full-time students in the Grozny and Baku petroleum technology institutes. In addition there are many hundreds receiving part-time instruction in different centers. The teaching personnel in these institutes work in close relationship with the field executives and research institutes. Students in the institutes receive free education and a living wage during the period of their training, and are assured a position in some technical capacity in the industry on completion. A new regulation, however, requires each technical graduate to spend a period of five years in practical oil industry work before he may assume an engineering position.

A vast amount of printing of petroleum technology literature is being done in Russia. In each oil field center — as at Grozny and Baku — daily oil industry newspapers are printed and attain wide circulation among the workers and people of the community. These papers carry more than the usual amount of technical material, and are carefully edited with the purpose of providing an educational medium rather than an ordinary newspaper. *Azerbajan Oil Industry,* an excellent petroleum technology journal, is published monthly at Baku. An oil industry information bureau prepares, publishes and circularizes translations of outstanding petroleum technology papers printed originally in other languages than Russian. A bibliography and abstract service is also maintained for the information of technical oil industry personnel. Well-organized petroleum technology libraries are provided in the various oil field and educational centers. Books printed in Russian, on every phase of petroleum technology are available to workers and students. Many of these are translations of standard reference works originally printed in English or German. The most complete and artistically arranged oil industry museum that the writer has seen is to be found in the "Palace of Culture" in Baku. This museum is finding many useful educational applications, and plans are now being made to duplicate it in other oil industry centers.

Technical specialists employed in the Russian oil industry have organized a technical society with sections in different producing and refining centers. A congress of delegates from different sections was held at Baku in August of this year and similar congresses are to be held at regular intervals in future. Proceedings, embodying the technical papers, discussions, recommendations and resolutions of these congresses, are to be printed in volume form. Through close association with those in executive control of the industry in different regions, this technical society wields a considerable influence over oil industry affairs.

Russia has looked to America for guidance in the development of her oil industry. The equipment and methods used are largely American in origin. Her technologists are influenced to an important degree by their personal observations on excursions through the American oil fields and refineries, by contact with American equipment manufacturers and by American technical literature. The immediate goal of Russian oil technologists seems to be to do their work as well or better than it is done in America. They are succeeding in this in large measure. In some respects they promise soon to lead. A well-developed phase in which they have even now outstripped their American contemporaries — that of oil production technology research — will be described in a second article, which will be printed in a forthcoming issue of *The Petroleum Engineer.*

A group of old-timers in the pipe line business. This gang is laying one of the first Gulf Pipe Line Company lines.

Geared Central Power on Circle Oil Company's River Bed Lease at Nocona

Installation of A Geared Central Power on River Bed Lease

Modern equipment will increase pumping efficiency in old field

LOW CRUDE prices work a variety of hardships on the oil operator, but the necessity for lower costs do put higher value on efficiency. Economical operation in producing areas calls not only for the installation of good equipment, but also its proper care.

The stripper well operator's problems have been particularly complex. Although realizing the high cost of using worn, inefficient equipment these operators, in many instances, have been unable to make essential replacements because of the low revenue return per barrel on their small quantity of production. Consequently, in the older fields replacement or repairing of equipment, as well as cleaning out to increase production, has become a dire necessity on many leases.

Today, a higher price for crude oil is giving operators of such leases more money for improvements and a greater incentive to produce more oil. Having learned the value of low operating costs, the stripper well operator, in a great number of instances, is now doing much work that will rejuvenate his property and aid in keeping production recovery on an efficient basis.

An outstanding example is the work just completed on the Circle Oil Company's River Bed lease in the Nocona field. There are many interesting things about this project. Much new equipment has been installed, requiring unusual modifications in construction and design at an added cost. This producing property is located in the Red River between Nocona, Texas, and Ringling, Okla. The loose, sandy formation at the surface is frequently flooded by high waters and therefore shifts often; conditions that necessitated extra labor and expenditure.

These wells have for a number of years been beam pumpers, and it was thought advisable to install a central power. The equipment consists of an Imperial "80" SC Oilwell geared power driven by a 65-hp. Franklin Valveless gas engine. Because of the inaccessible location of the lease it was necessary to haul this heavy machinery to the power site on flat skids rather than with trucks. This feat was accomplished by the use of a common winch line.

The surface soil, which is loose and unconsolidated, necessitated the use of heavy piling to construct suitable foundations on which to set all the machinery. Ninety-eight piles, consisting of a 6⅝-in. drill pipe, were driven 36 ft. deep. As a protection against the overflow conditions, the concrete foundations were set with their tops four ft. above the ground level.

Although only 21 rod lines are connected to the power crank, a total of 42 wells, all producing from the 1200-ft. sand, are being pumped from this new geared central pump station. This is the largest number of wells to be operated from one geared central power. At selected points on rod line, usually near the first well, a multiple swing is installed. Two rod lines, one to each well, are laid from the multiplier so that two wells can be pumped from each pull line connected to the power. The Imperial "80" SC geared power is regularly equipped with an 18-in. or a 15-in. throw, giving 36-in. and 30-in. strokes respectively. Since it was desirable to pump these wells on a 20-in. stroke, a special crank with a 10-in. throw was made and attached, on top, to the regular crank. This is only the second time that this special added crank connection has been used with geared powers to provide the desired length of stroke to meet local conditions.

Longest Gas Line Project Of Year Nearing Completion

By J. F. WEADOCK

Mountain-Desert Country Presents Some Unique Problems

Electric welders welding joints of pipe into one long, continuous tube

Few Cities in the Southwest Now Without Natural Gas

ONE of the last gaps in the distribution of natural gas to the cities of the Southwest will be closed when the Western Gas Company completes, around the first of the year, its 217-mile pipe line from Douglas, Arizona, to Phoenix, Arizona, via Tucson. When gas is delivered to the gate at Phoenix there will be very few large cities in the Southwest without natural gas facilities and they are so located as to be advantageously served from the west coast fields. Approximately, this line will have ended the march over the trail that brought the hunter and trapper, the miner and the cattleman, the wagon train and stage coach, the railroad and the airline. For the Western Gas pipe line follows the old trail that leads from the Southwest to the Pacific.

This line is a continuation of the distributing system of Western Gas' parent company, the El Paso Natural Gas Company, which extends from the Lea County, New Mexico, gas field to El Paso, Texas, and which was extended from there, by the Western, to Douglas and Bisbee, Arizona, and Cananea, Mexico.

The contract for laying the 23,000,000 pounds of steel used in the final extension of the line was let to the Bechtel-Kaiser Company and Henry J. Kaiser, Ltd., of San Francisco, California. It was these organizations that met the novel labor problem involved in the construction, accepting the proposal to use hand labor on the work as an employment relief measure; obtaining this labor, county by county, along the right-of-way, with the aid of county and state welfare boards. Only technicians and skilled labor were hired for the full extent of the job.

No camps have been used, the workmen live in their own homes and are provided transportation to and from the job. The average payroll of the company carries 500 names and the pay checks are being spent in the communities in which the men live. There are no commissary deductions nor other camp costs and the relief phases of the plan have proved of great aid to the smaller communities along the route.

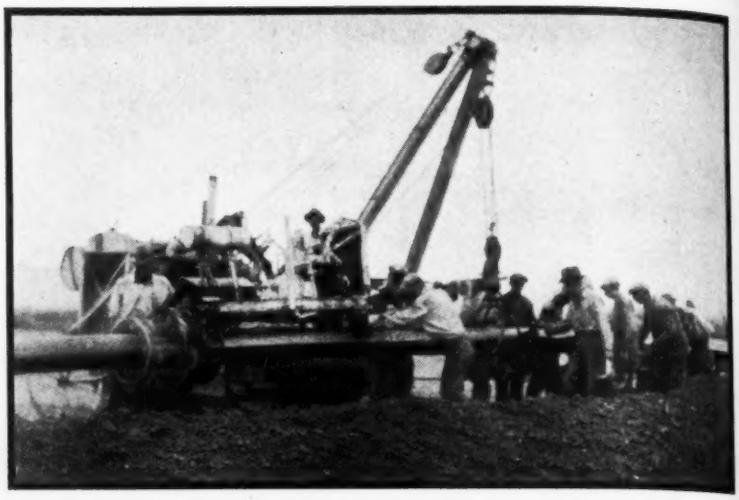
The use of hand labor and the topography between Douglas and Phoenix brought about a change in the original estimates of both the contractors and the gas company. In the initial survey it was estimated that 1600 bends would care for the variations in elevation between the two terminals. The figuring of elevations in these estimates, however, failed to take into consideration the variance between ditching machinery and pick and shovel ditching, which, under the agreement, the company was to use for the line. The 1600 bends have increased to 4000 and the end is not yet!

In this mountain-desert country the inroads of erosion along the slopes leading down into the river valleys have been very great. The foothill country especially is cut again and again with washes and arroyos of varying depths. In crossing these the narrow ones are spanned, with good results. But in other places the line is being laid beneath the bottom of the wash. Hence the increased number of bends and the additional figures on the estimate sheets. The contractor has made all the bends with cold pipe, the company having ruled out the hot bend.

The clearing of the right-of-way and for the trucks distributing the pipe has been speedily handled through the use of a Caterpillar Diesel "75" tractor that is equipped with a heavy steel grader blade rigged ahead of it. The equipment has been very effective. Desert trees, scrub and brush are rooted out with little difficulty and even giant cactus fall readily before the power of this heavy tractor. The right-of-way prepared by this equipment is, with minor work in washes and gullies, ready for the trucks. Except where the grade is too steep, the roadway follows the right-of-way for the pipe line.

Transferring the 40-ft. lengths of pipe from railroad cars to the trucks is done with a crane-rigged truck. From the truck to the right-of-way the pipe is rolled off by hand, with a "buffer", made of six old truck tire casings, for the joints to land on. This buffer is drawn along the side of the truck as unloading operations advance and prevents any denting or damaging of the pipe, even in rough rocky territory, when it strikes the ground.

The pipe being used on this line was purchased from the A. O. Smith Corporation and Republic Steel Corporation. The pipe from both mills is electrically welded, 10¾-in.



Pipe cleaner, powered from crane-rigged tractor, is followed by enameling crew

O.D., has a wall thickness of .203 in. and weighs 22.866 lb. per foot. The pipe is furnished in 40-ft. joints, plain end and bevelled 30 degrees.

The depth of the ditch varies from 30 in. to 42 inches. Little grading is needed in preparing the bottom after the laborers have finished their job.

The pipe, which has been strung along the open ditch, is then rolled on to girders laid across the ditch itself and the welding crews, their equipment mounted on a small truck, go into action. All joints are being electric welded, and inside chill rings are being used. These rings, manufactured by the same mills producing the pipe, expedite the field welding. H. C. Price, Inc., Bartlesville, Okla., is doing all the welding work and is using Fleetweld elctrodes and machines made by The Lincoln Electric Company, Cleveland, Ohio. Each welder faces the certainty of a test of his personal work. This test, made with an Oxwell Tensile Tester, mounted on a running board of a car, follows the welders, each of which stamps his work with a small die. Very good welding speeds are being made. According to Mr. Price the firing line welders are averaging over 50 welded joints per man per day.

The testing operator occasionally cuts a coupon, containing a weld, from the line. This coupon, one in. wide, is then given a dual test. One is a bending test, with the bend being made at the weld; the other is a pull test where the coupon must stand up under 60,000 lb. per sq. inch. A test sheet for more than 20 such tensile tests showed the pipe, in each instance except three, broke before the weld. The pipe will pull down to half its original wall thickness before breaking. The three welds that broke took over 80,000 lb. before giving away, more than 20,000 lb. over the required 60,000 pounds. The parent stock in the pipe is strong enough to handle that excessive strain and more.

While the corrosive effects of the ground through this territory, where much of the land is highly mineralized, is not known, A. L. Forbes, general superintendent for the Western Gas Company, is taking extra precaution against earth electrolysis.

After the pipe has been welded and inspected, a pipe cleaner mounted on a truck rig polishes the pipe, then an insulation crew, following the cleaner, "rags on" the Barrett Pipe Enamel, which is being applied hot. This insulation is then tested with a device evolved by the contractors. It is wire loop of sufficient size to encircle the pipe. In this loop lighter wire feelers, or cat-whiskers, reach out in brush-like fashion, contacting the entire surface. One pole of the loop is connected to a battery, the other to a coil. An open spot in the insulation furnishes a ground and a spark, naturally, results, making it easy to find any unprotected spots. These points, when found, are ringed by the inspector and a dauber crew, following him, applies a heavy coating to all the insulation breaks so marked.

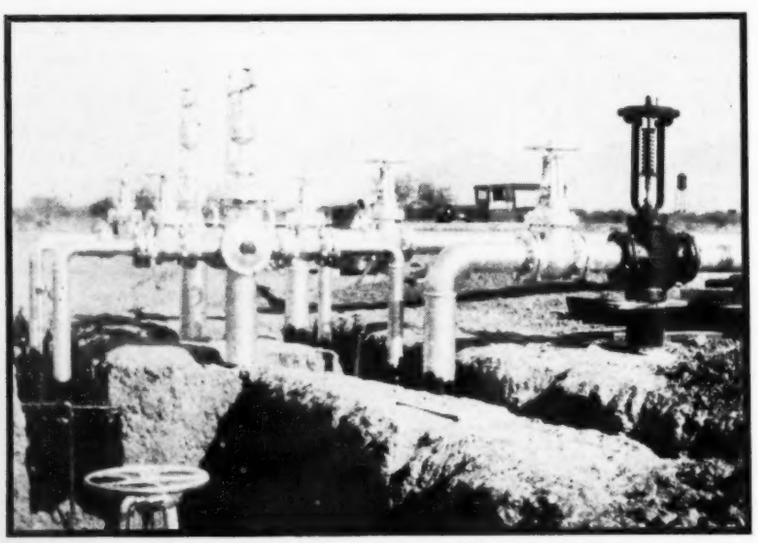
Main gate valves are being installed approximately eight miles apart. These are 6-in. Crane valves and are connected into the line by means of 10-in. by 6-in. Venturi swedge nipples. Numerous tests have been run to determine the pressure drop across such an installation and it has been found to be negligible.

As the construction of the line proceeds each eight-mile section is blown out with natural gas to clean the interior of any foreign matter. The line is then subjected to a pressure test of 650 lb. to the sq. inch. This pressure is allowed to remain in the successive sections so that when all work is completed the first part of the system will have been under test during the entire construction period.

The personnel handling this construction job includes Paul Kayser, president of the Western Gas Company, H. G. Frost, its general manager and vice-president, and Russell Branch, Western engineer; Henry J. Kaiser of the two contracting companies and his engineer, C. P. Bedford, in charge of construction, with A. L. Forbes, Jr., of Western Gas as general superintendent of the entire job.

The original line of the Western Gas, El Paso to Douglas, was brought into Arizona under direct contract with the copper companies at Douglas, Bisbee, Arizona, and Cananea, Mexico.

Douglas, a smelter town, home of the Calumet and Arizona copper companies, furnishes an industrial market for gas, with but little else. Bisbee, another mining city, home of the Phelps Dodge Copper Queen and other large properties, is also an industrial user as is Cananea, where the Greene-Cananea Copper Company holdings are



The Tucson gate and meters all finished with an aluminum-colored top coat

One of four compressor stations located on the older part of the line. Another has now been constructed at Phoenix, Arizona

located. The domestic use of naural gas is secondary in these localities.

However, the lines of the company into Cananea, Mexico, brought out a unique result. The line there was looked upon merely as a service to the copper company for industrial fuel. Domestic use of gas in Mexico had, according to company officials, been a failure as a revenue producer before. They made the domestic provision for Cananea with no thought of it showing any material profit. But they had figured without the large American colony that exists there to operate the mines. The domestic use of gas here has proved quite profitable since it was installed and practically every American home in the mining camp is serviced; also a few of the Mexican homes now use gas due to the example set by their neighbors.

The low level of the copper market at the present time, with the demand for the metal almost at a standstill, and most of the mines either closed or working but a small fraction of their total capacity, has cut down sharply on the industrial needs for gas and makes this demand a very unstable one.

The extension of the Western Gas Company's distributing system from Douglas to Tucson and thence to Phoenix opens up a new and more stable field.

Tucson is a city of homes. It has no industrial demand for the gas to speak of, but more than 5000 domestic installations of artificial gas are already in use, twice that many being available with the arrival of natural gas in the city. In addition there will be some, although comparatively small, commercial use of the fuel in Tucson.

Phoenix presents a similar picture on a large scale and has, in addition, an already large industrial demand, which, it is anticipated, can be materially increased. The extension of the line to the two cities, the largest in Arizona, furnishes a stable demand for the product.

The distribution of the gas in Tucson, where the Western will deliver it to a gate at the edge of the city, will be made through the mains of the Tucson Gas Electric Light and Power Company, while in Phoenix the distribution is made through contract with the Central Arizona Light and Power Company.

Two outstanding stretches of the route from New Mexico to El Paso stick in the minds of the pipe liners. They are interesting to review at this time, because the new line is an extension of the El Paso Natural Gas Company's system. One is the crossing of the rocky ramparts of the Guadalupe Mountains, in New Mexico, the other the broad salt flats in the same state.

In crossing the Guadalupes the 40-in. ditch was cut in the rock face of the mountains, dropping down a 45-deg. slope where every joint was grouted into the rock to prevent slipping and pulling. In each of the severe drops a dual line construction was used, with gate valves inserted at both ends of the strip, and was employed in both main line and by-pass lines,

On the salt flats, a wide expanse of level lake bed with a salt floor, the line met another problem. The corrosive effects of the salt-filled earth were not fully known, so the company laid a by-pass line under ground, heavily protected with an asphaltic base enamel coating, pressed into a burlap wrapping. Applied under pressure this coat is about one-half inch thick. The main line runs above ground, set on piling driven eight ft. into the lake bed. The line above ground is enameled and then painted with aluminum paint, making it one of the show places of the entire route.

River crossings were treated the same way in one instance, namely the Pecos River, which was crossed in New Mexico. The span there parallels the highway bridge, is aluminum painted, and the by-pass runs under the river bed.

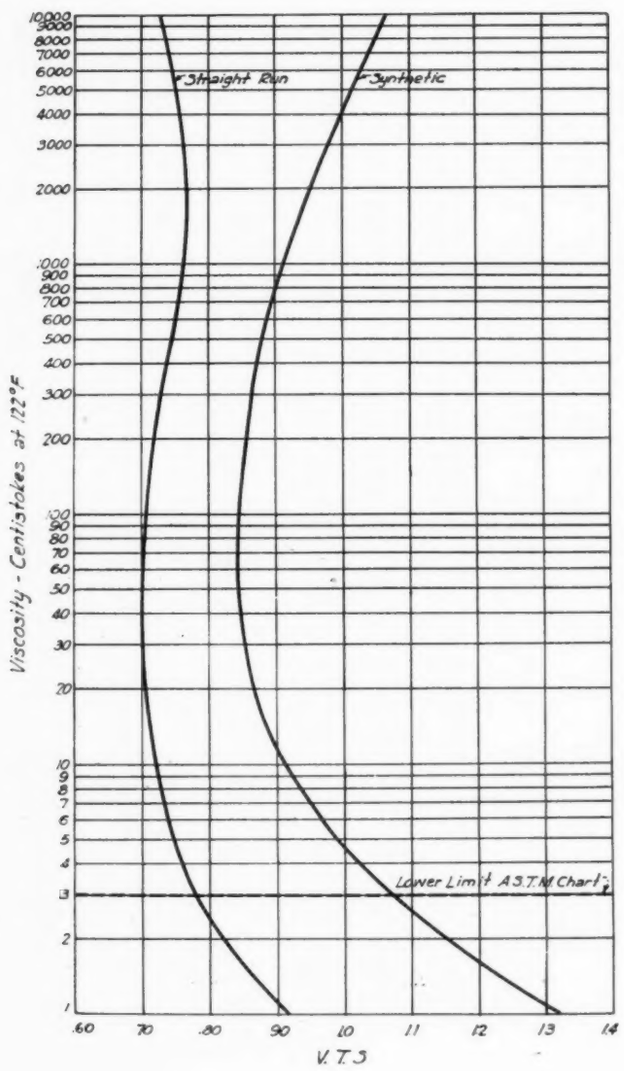
On the San Pedro and Santa Cruz River crossings the multiple line plan was used again, but both lines were laid in the river bed. In both these crossings, two lines of 8⅝-in. O.D. pipe were manifolded together on each side of the river. Six-inch gate valves were installed on each side of the two lines and on each side of the river. A main line gate valve was also installed on both sides. This permits very flexible operation and either one or both lines may be used. A universal sleeve connection on either side of the river provides for elasticity in the line and permits the raising or lowering of the shifting stream bed to occur without affecting the line itself. In all these crossings 1500-lb. clamps were also used to assure stability.

The Viscosity Temperature Susceptibility Coefficient

By H. G. NEVITT
Manager Road Oil and Asphalt Department
White Eagle Oil Corporation

The Second of Two Articles on This Subject

THIS information can be obtained directly from the A.S.T.M. chart. In the first case the two viscosities can be plotted and the slope of the line connecting them read. In the second a line of the known slope can be constructed through the point corresponding to the known viscosity and the viscosities at the other desired temperatures read. Both of these require some time that would be saved if a chart were available from which the information could be read direct. As long as only two or three temperatures are read, such a chart can be easily constructed. The theory and construction are explained following.



Take the temperature-viscosity diagram as published by the A.S.T.M. Assuming we are working with two temperatures as standard, 100 deg. fahr. and 210 deg. fahr., it is desired to have a chart from which, with these two viscosities, the temperature susceptibility coefficient (slope of the line between the two points corresponding to these viscosities) can be read directly.

Let $X_{100/210}$ be the horizontal distance measured on the chart between the temperature lines for 100 deg. fahr. and for 210 deg. fahrenheit.

Let S be the V.T.S.

For a known value of S, let Y be the vertical distance on the chart between the points for two viscosities at 100 deg. fahr. and 210 deg. fahr. corresponding to the value of S. Then:

$$Y = SX_{100/210} \quad \text{Equation 6}$$

Assume we plot a new chart with the same viscosity scale as the A.S.T.M. chart has identically for both ordinates and abscissas, as shown in Fig. 1. (See first article, Nov. issue).

Through the point of origin of this new chart draw a 45-deg. line. Then all points on this line will read the same viscosity on both scales. At a distance Y above this 45-deg. line draw another line parallel to the 45-deg. line. This line will represent the value of S on the chart. That is, the intersection of 210-deg. fahr. viscosities on the horizontal scale with 100-deg. fahr. viscosities on the vertical scale for all materials with a V.T.S. equal to S will be on this line. In this way the accompanying chart can be constructed and used (Chart No. 1).

Proof of the construction is obvious. In every case the 100-deg. fahr. viscosity location on the scale is a distance Y from the 210-deg. fahr. viscosity.

For other sets of standard temperatures similar charts can be drawn. The construction is so simple that this is usually desirable if any great use of such other temperatures is to be made. Chart No. 2 is an example. However, the 100-210 chart can be readily made utilizable for such other temperatures by an additional supplementary chart. The construction can be developed as follows:

Let $X_{M/N}$ be the distance on the A.S.T.M. chart between the two temperatures M and N that will be used instead of 100 and 210 deg. fahrenheit. Similarly for a V.T.S. of S as before, $Y_{M/N}$ will be the vertical distance between the points on the A.S.T.M. chart corresponding to the two viscosities for M and N, so that:

$$Y_{M/N} = SX_{M/N} \quad \text{Equation 7}$$

Take the 100-210 chart already constructed, and locate the point corresponding to the above M and N viscosities.

Chart 3—Typical trend of viscosity vs. viscosity temperature susceptibility coefficient for straight-run and synthetic road oils

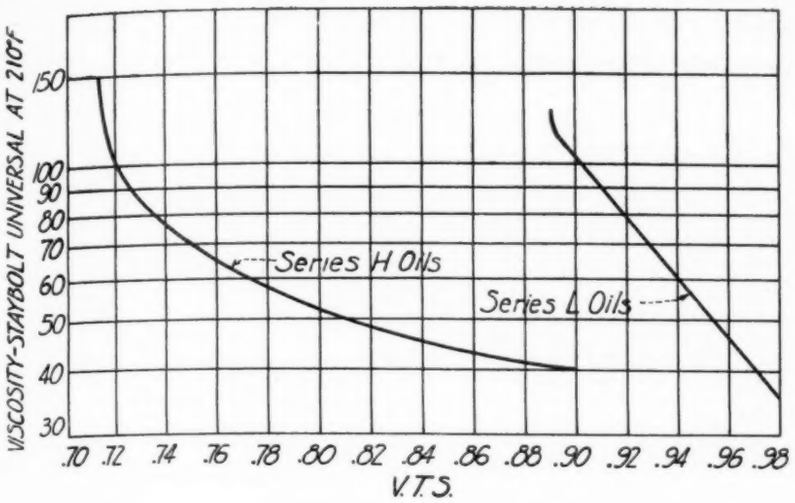


Chart 4—V.T.S. of L. and H. oils used in defining viscosity index

This point will correspond to some value of the V.T.S. for the 100-210 values, which we will call the apparent coefficient, S′.

Then from the construction of the chart:

$$Y_{M/N} = S' X_{100/210} \quad \text{Equation 8}$$

but from Equation 7:

$$Y_{M/N} = SX_{M/N} \text{ so that}$$

$$S' X_{100/210} = SX_{M/N}$$

$$S' = SX_{M/N} / X_{100/200}$$

Since the values of $X_{M/N}$ and $X_{100/200}$ are constant and known, their ratio can be determined, and the chart used for the temperatures M and N instead of 100 and 210 by converting the actual susceptibility coefficient S to the apparent coefficient S′.

To simplify the conversion from S to S′ a supplementary chart is given. The construction is obvious, based on the use of logarithmic scales and the equations:

$$S' = SX_{M/N} / X_{100/200} \quad \text{Equation 9}$$

$$\text{Log } S' = \log S + \log (X_{M/N} / X_{100/200})$$

Lines for values of

$$X_{M/N} / X_{100/200}$$

for sets of temperatures in common use are plotted. From them the proper S′ corresponding to any value of C can be read.

The V.T.S. in Use — Application to Oils. The relations of the V.T.S. with other data along the same lines may be of interest. The typical values for products of different viscosity of two types are shown on Chart No. 3. These were chosen to show the extreme variation usually encountered. On the straight run materials the V.T.S. remains roughly constant until the proportion of low boiling point constituents becomes large. The synthetic materials show higher than the straight-run at all times, with a decrease in the V.T.S. as the asphaltic fraction becomes a smaller proportion of the whole, until low viscosities are reached. Paraffinic oils show a curve closely corresponding to the straight run asphaltic materials but with somewhat lower values (it is estimated liquid paraffin wax has a V.T.S. around 0.70). The rapid increase in V.T.S. in the lower part of Chart No. 3 around and beyond the lower range of the A.S.T.M. indicates either the lack of applicability of Equation 3 to this range, or marked change in viscosity-temperature characteristic of these lower molecular weight hydrocarbons. The former seems more probable in view of the fact that blends of high V.T.S. low boiling constituents with high V.T.S. synthetic asphalts give a lower V.T.S. than either and in line with the expected value from an intermediate product of the same viscosity as the blend. This conclusion is also indicated by other data previously mentioned. However, in the usual working range of any particular commercial product, where the basic composition of the material remains essentially the same, the V.T.S. is essentially constant for the same type of material and in practical use classifies it.

Since the most commonly used criterion of viscosity-temperature characteristics is the viscosity index for lubricating oils, along the lines originally suggested by Dean and Davis, some comparisons of the V.T.S. and the V.I. should be of interest. First the viscosity-temperature characteristics of the reference standard oils used (not as originally given by Dean and Davis but as later modified by them and LaPeyrouse) are given in Chart No. 4. In this chart the V.T.S. for the L and H series from these authorities are given, plotted against the 210-deg. viscosity. The values show a uniformly increasing V.T.S. with decrease in viscosity. Part of this increase is probably due to the tendency for the V.T.S. to increase in this lower range of viscosities, as shown by Chart No. 3. Not all of it can be attributed to this reason, however; probably present sales requirements for color, oxidation or similar force the use of methods, or degree of treatment, on the higher viscosity oils that tends to remove the higher V.T.S. components to a greater extent in such grades. The theory has been advanced that the viscosity lines of different products from the same source, when plotted on the A.S.T.M. chart, meet in a common point on the chart, but this has not been the writer's off-hand observation on such products when subjected to no other treatment

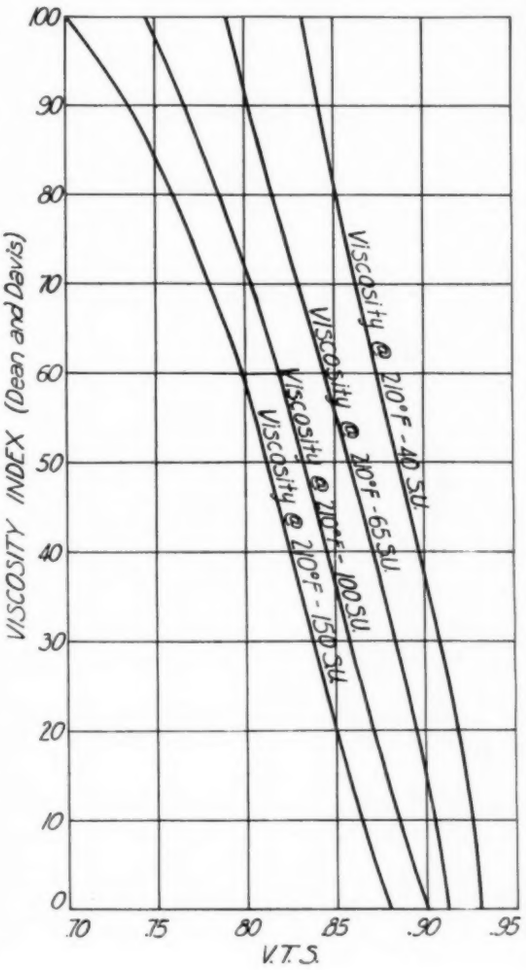


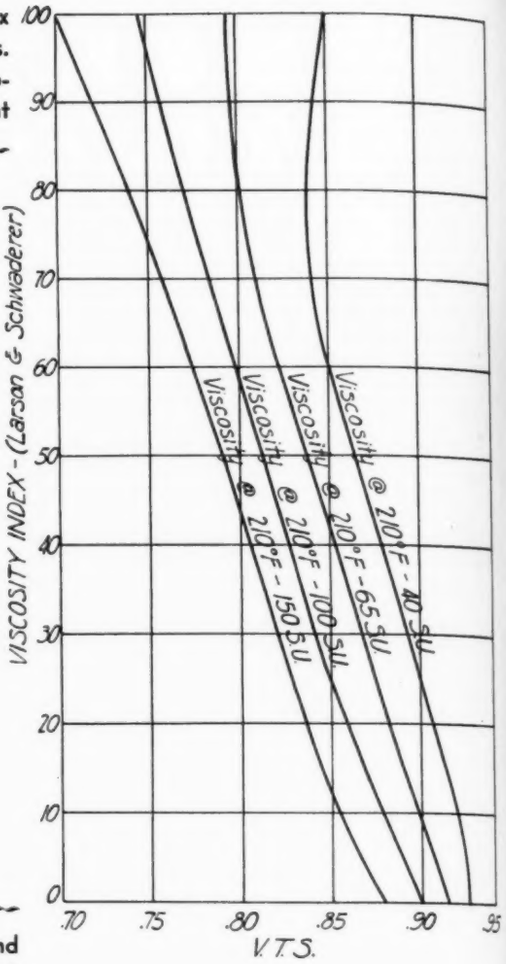
Chart 5—Viscosity Index (Dean & Davis) vs. viscosity temperature susceptibility coefficient

than distillation, especially with the higher viscosity straight run asphaltic materials.

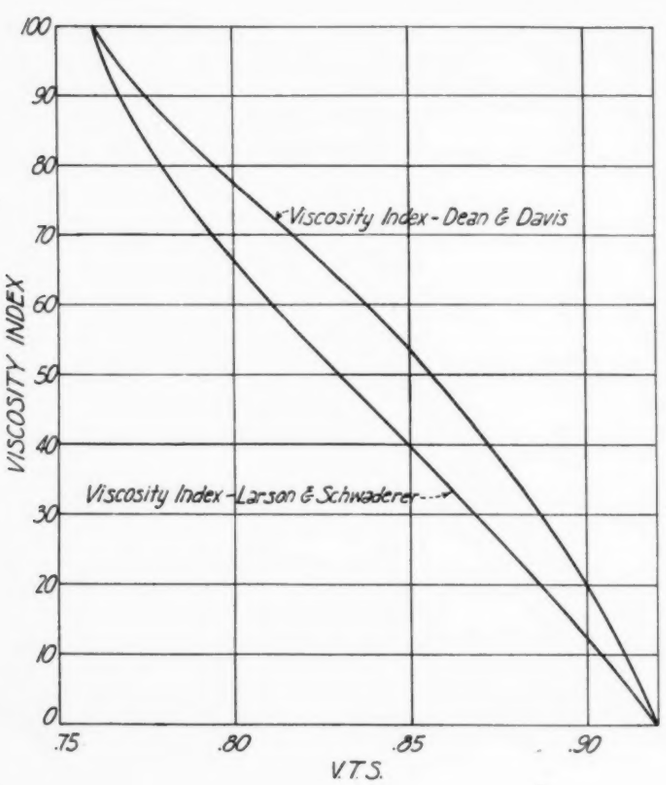
Since the reference standards used have a variable V.T.S., it could be anticipated that the V.T.S. corresponding to any viscosity index would be a function of both the viscosity at 210 and the viscosity-temperature characteristics. This is brought out by Charts No. 5 and 6 where a number of viscosity index versus V.T.S. comparisons for 210 viscosities of 40, 65, 100 and 150 are plotted, for the Dean and Davis, and the Larson and Schwaderer indexes respectively. Also Chart No. 7 shows the two viscosity indexes compared to the V. T. S. for a common mid-range viscosity oil.

Even though the difficulties referred to preceding were removed, the basic idea of the viscosity index, as an arithmetical proportion of the lower temperature viscosity between the corresponding values of two standard materials with the same higher temperature viscosity, is not quite in line with the actual functional variation of viscosity with temperature for different viscosity-temperature characteristic materials. For example, assume two oils of 0.82 V.T.S. and 100-S.U. and 200-S.U. viscosity respectively, which bring them well within satisfactory working range of the A.S.T.M. chart. Assume the reference standards of these same 210 viscosities have V.T.S. coefficients of 0.70 and 0.90 respectively, as the oils discussed have a V.T.S. midway between these standards. The V.I. of the two oils will be 34.1 for the 100-viscosity material, 33.0 for the 200-viscosity material, instead of being uniformly 50. The difficulties of using a simple arithmetical proportion on functions, which at the simplest are of the exponential and logarithmic type, as is the relation between viscosity and temperature (and also probably the relation between viscosity and molecular weight, or similar comparative standard for materials from the same source), are obvious. It is essentially this same point that causes Larson and Schwaderer[8, 9] to define their viscosity index differently from Dean and Davis[1, 2] even though based on the same standards. Their equal angular chart of zone divisions on semi-logarithmic paper comes nearer to representing the variation of the function than the arithmetical proportion of Dean and Davis, as indicated by the more uniform relation with the V.T.S. (Chart No. 4), but this only partially overcomes the objections to the V.I. basic concept.

Chart 6 — Viscosity Index (Larson L. Schwaderer) vs. viscosity temperature susceptibility coefficient



Below: Chart 7—V.T.S. and Viscosity Index for oils of 80 Saybolt-Universal viscosity at 210 deg. fahrenheit



It would appear that the viscosity index as now defined is an arbitrary figure applicable only to the lubricating oil range. Essentially it is an empirical and reference value, with convenience in a limited field. On the other hand the V.T.S. is more a scientific and absolute measurement of the same characteristic, without the limitations inherent in the viscosity index as now defined; it seems to offer substantially the same convenience in practical use, along with its scientific advantages, to those familiar and experienced in the actual use of both systems, but this remains to be seen. Meanwhile the development of the V.T.S. or some similar measurement was necessary for workers in other products due to the present limitation of the viscosity index to lubricating oils.

In connection with the use of the V.T.S. for commercial lubricating oils, the greater accuracy in its measurement indicated can be met by a large scale chart for the range encountered in actual practice. Chart No. 2 was primarily developed for all products, praticularly residuals. With such a larger scale chart accurate results in the use of the V.T.S. are easily obtained, and the use of the V.T.S. makes the data obtained independent of the heavy and light oils selected as standards for the viscosity index.

The relationship between the V.T.S. and the viscosity-gravity constant, as suggested by Hill and Coats,[6, 7] was only

(*Continued on Page 32*)

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Quarter-Turn Belt Drives

BECAUSE of the side pull that is inevitable in most quarter-turn belt drives, one edge of the belt is stretched more than the other and in time the belt is likely to become crooked. It then begins to work over to one side and in time will run off. Also the joint is likely to open on one side.

Where the distance between pulleys is sufficiently great this can be remedied by giving the belt a half twist. That is, instead of cementing or joining the belt in the usual way, turn one of the ends through 180 degrees. Then join the two ends together. This half twist causes the belt to change sides with every other revolution of the belt and the tension on both edges is thus equalized.

By W. F. SCHAPHORST
Mechanical Engineer

A good rule to follow in laying out quarter-turn drives is this: the distance between shaft centers should be at least five times the diameter of the larger pulley. Thus, if the larger pulley is 20 in. in diameter, the distance between the shaft center should be at least 100 inches.

A properly designed quarter-turn drive will transmit almost as much power as normal open drive under the same conditions. But it is wise, nevertheless, to use a belt from five to ten per cent wider in order to assure a sufficiently high factor of safety. Wherever it is possible the pulley on the vertical shaft should be the driver, that is, provided one of the shafts must be vertical. This is so because then the tight side of the belt runs onto the pulley the plane of which is horizontal. Obviously, if there is any slackness in the belt, trouble will be experienced, especially if the pulley on the horizontal shaft is the driver.

In the event that the pulley on the vertical shaft is the driven pulley, with the belt persisting in running off, tightening the belt is one remedy. If it still persists in running off it may be necessary to increase the crown of the pulley on the vertical shaft.

The Viscosity Temperature Susceptibility Coefficient

(*Continued from page 30*)

superficially investigated. Apparently there is a connection between the V.T.S. and a gravity viscosity parameter similar to that indicated by Larson and Schwaderer[8, 9] for the V.I. and the viscosity-gravity constant; also the V.T.S. is a more logical measurement to correlate with such a parameter since it is essentially independent of the viscosity over the range of the applicability of Equation 3.

One point that should be emphasized in the use of any temperature-susceptibility measurement whether the V.T.S., V.I., or other, is the effect of waxy or crystalline materials present. Experience with residual fuel oils indicates that where the wax is much over two or three per cent the V.T.S. based on viscosities at 122 deg. fahr., or below, may not be consistent with the characteristics of the material in its truly liquid state; also that this effect enters into the relations wih any viscosity-gravity functions developed.

In conclusion, a brief review of the viscosity-temperature relations of liquids, more particularly oils, has been made. A viscosity temperature susceptibility coefficient, based on the A.S.T.M. viscosity-temperature chart, has been suggested to define this characteristic. In the usual range of viscosities this coefficient, the V.T.S. is essentially independent of the viscosity. A chart to permit its easy calculation for usual standard temperature viscosities is given, with the method of making explained.

The V.T.S. so defined seems to offer advantages over others so far proposed. It is applicable over a wide field. In its use two independent values, the viscosity at a standard temperature and the V.T.S., serve to define completely the viscosity-temperature characteristic of a liquid over the range in which the basic equation:

$$\text{Log } A\ (V + B) = KT^e \quad \text{. . . . . Equation 3}$$

is applicable. The V.T.S. can be obtained very quickly in actual use by suitable charts. Its relationship with other usual data is indicated. In general the need of a measurement to cover more than the field of viscosities of lubricants has been needed, and the V.T.S. appears best to meet the technical and practical requirements of this as far as this is possible with the information at present available.

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Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Production

Article 2

EQUIPMENT AND OPERATION OF OIL WELLS

By K. C. SCLATER

THERE is today a surprising variety of equipment in use at wells for the production of oil. By grouping oil wells according to their method of production the study of their equipment and operation may be simplified. Of the various types of wells discussed last month the three most important groups are: (1) Naturally flowing wells; (2) Gas-lift wells; and (3) Pumping wells. These comprise the bulk of all oil wells producing today. In each group the general principles of well operation are the same although the equipment employed may vary in kind.

No matter in which field or in which part of the country wells may be situated or what may be the local conditions, the fundamental principles of modern well production practice hold good, even though the method of operating, and hence the equipment, may have to be modified to overcome difficult conditions peculiar to the well, the field, or the district.

So long as wells were shallow not much attention was paid to the principles of well operation. Difficulties were more easily overcome and wells could be produced economically down to a rate of a fraction of a barrel a day. As wells increased in depths, rule-of-thumb methods had to be discarded. It was gradually realized that more scientific methods of production were needed; and that conditions in the well and the producing sand should be ascertained and used as a guide in deciding how best to produce the well. The deeper the well the greater the difficulties and the need for the exercise of care in well operation. In the last ten years, great progress has been made in developing sound scientific principles of production.

It is with these aspects of modern production practice that we are here chiefly concerned.

Naturally Flowing Wells

A naturally flowing well that is not properly equipped and operated at the time it is brought in can be a source of great loss. The bad effects resulting from unnecessary waste of gas energy during this period may be felt throughout the whole life of the well. We can well afford, therefore, to dwell at some length on the principles of operation of naturally flowing wells.

All oil sands when first drilled into are under pressure. For all practical purposes the virgin pressure in an oil sand is usually assumed to be roughly proportional to the depth, and equal to the pressure exerted by a column of water at that depth. It is approximately one lb. per 2.3 ft. of depth or 43½ lb. per 100 ft. of depth. Thus for a 4000-ft. well drilled in virgin territory the predicted pressure would be 40x43½, or 1740 pounds.

The rate at which oil will flow into the well from the producing sand is dependent on the pressure held at the face of the sand in the well. It is also dependent on the diameter[5] of the hole and the amount the oil sand was penetrated. The well having been completed with a fixed diameter and length of hole into the producing sand, it becomes a question of equipping and operating the

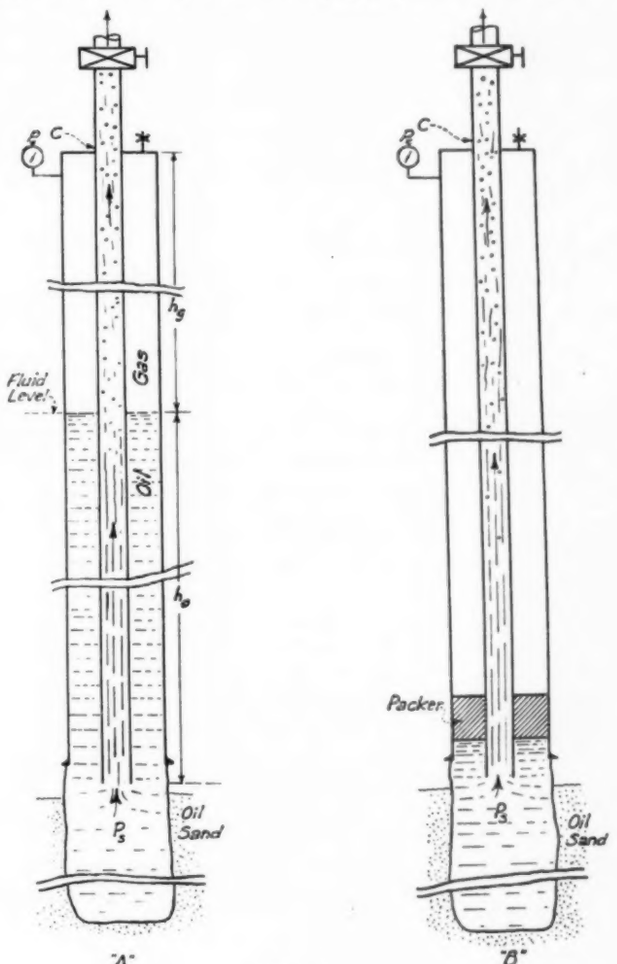

Fig. 1

well so that it will produce at the desired rate in the most economical manner. Since the rate at which a well produces is governed by the pressure held on the face of the sand[6] a knowledge of how this pressure on the face of the sand may be controlled becomes of great importance to the field man responsible for producing the well efficiently.

A naturally flowing well offers the simplest case of applying pressure control. Assume that such a well has just been placed on production and the pressure at the face of the sand

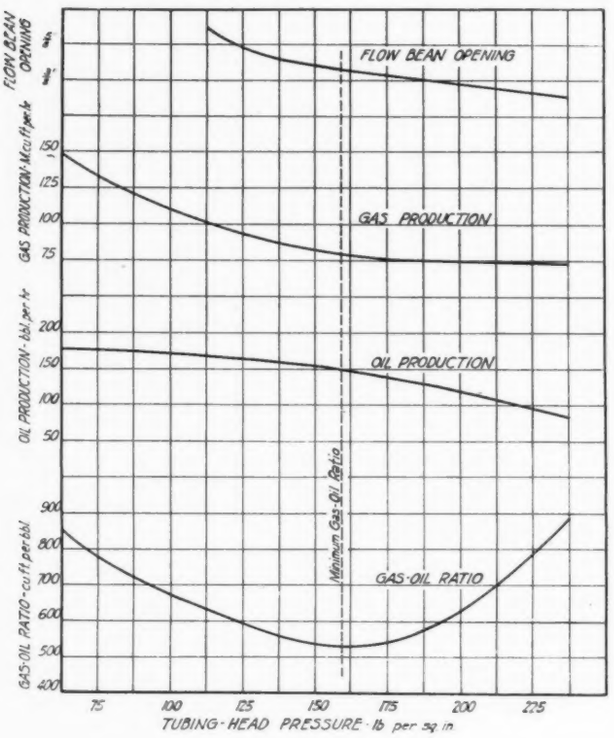

Fig. 2

has been determined. This latter is done by means of bottom-hole pressure gauges.[7]

If we were to test the flow of the well by varying the pressure at the face of the sand it would be found that not only would the total quantity of oil and gas produced vary, but also the relative proportion of gas to oil.

When a well is produced unrestricted through the casing the rate at which the average flush well will flow is usually greater than the quantity of oil it may be allowed to produce. Not only that, producing the well through the casing will, in a short time, become very wasteful of gas. It will usually be found that the well will begin to "head" in a comparatively short time. The well by then has reached a stage where the oil is not able to come into the hole fast enough, or there is insufficient gas to maintain continuous flow to the surface. The slippage of gas in the flow string will become excessive and the gas-oil ratio become correspondingly large. Thus can great quantities of gas energy be dissipated during the flush period of the well's life. By installing a string of tubing in the well when this period is reached the flowing life of the well may be prolonged.

It is only within the last few years that it has become general practice to tube wells as soon as completed. In fact, in the old days when a well was completed as a good producer flowing through the casing it was not possible to run tubing without grave danger. When a well had once started to flow through the casing, the only way in which tubing could be run was to kill the well. This could not always be done successfully without running the risk of damage to the well. The result was it would be allowed to produce through the casing until it started to "head" seriously or "died" altogether.

Today equipment is available for running tubing under pressure.[8, 9] It has also become general practice in deep fields to run tubing in the well before bringing the well in. This means of completing a well is usually adopted on rotary-drilled wells.

Where a well is flowed through the casing it is now considered good practice to use a flow bean. By its use the rate of flow can be controlled and the gas-oil ratio reduced. Close control of the rate of production and the gas-oil ratio can best be accomplished by using tubing in the well. Regulation of the flow by a flow bean or choke nipple is now general practice. State regulations in some fields require that all wells be equipped with tubing on completion. This is regarded as a conservation measure to prevent unnecessarily high gas-oil ratios. Another factor that fosters the use of tubing in flush wells is the proration regulations now in force. There is a trend now toward limiting the amount of gas that may be produced with the oil. Gas being the medium that flows the oil to the well and aids in lifting it to the surface, its conservation is important in an oil field.

The proper rate at which a well should be produced is best determined by test. Some wells produce at too high a rate. These are usually flush wells. In such wells reducing the gas-oil ratio also causes a reduction in the rate of oil production. In other wells, usually old ones, that produce at too low a rate, a reduction in the gas-oil ratio will cause an increase in the rate of oil production. Such adjustments in rate of flow can usually be made if founded on reasonably accurate test data.

If the well is a high-pressure well of large capacity having oil and gas in quantity, the tubing is usually packed off at the casinghead and a Christmas tree with the necessary control connections placed on the well. If a smaller well with low fluid level and with limited production of oil and gas it may be necessary to install a packer on the tubing to get the well to flow satisfactorily in sufficient quantity.

In Fig. 1 two such wells are shown as "A" and "B." Well "A" is packed off at the casinghead at "C." When it is flowing the pressure conditions in the well will be somewhat as shown. The pressure P_s at the entrance to the tubing will be equal to the pressure of the oil and gas columns behind the casing plus P_c, the pressure of the gas in the top of the casing or:

$$P_s = h_g + h_o + P_c$$

By varying P_s we may control the rate of flow through the tubing. This is done by inserting a flow bean in the tubing at the head of the well. A flow bean is nothing more than a restricted orifice.

In order to determine the minimum gas-oil ratio and the corresponding rate of production we may, by adjusting the flow bean opening, adjust the rate of flow and measure the gas-oil ratio when conditions in the well become steady. If we measure the quantity of oil and gas produced at various rates we can compute the corresponding gas-oil ratios. In this way we can determine the most desirable rate at which to produce the well.

Where the fluid level is very low and the volume of gas produced is small the flowing condition of the well may be improved by the use of a packer run on the tubing. In such a well the packer may be set below the fluid level as shown in Fig. 1 "B", or it may be set above the fluid level. When the well reaches the point where the flow becomes sensitive to slight changes in pressure the use of a packer in this manner will give a little closer control of the pressure at the face of the sand than can be obtained when the tubing is packed off at the casinghead.

If the pressure in the casing above the fluid level, Fig. 1 "A", is too great it will affect the pressure P_s at the face

of the sand sufficiently to prevent oil and gas coming into the hole and kill the well. Sometimes the fluid level alone will build up to a point sufficient to kill the well. In such cases, sometimes bleeding off the gas at the casinghead will be sufficient to establish the proper pressure conditions on the face of the sand. For this purpose it is well to have a small needle-valve connection on the casing.

By running a series of tests in the field at different rates of flow with different bean openings the minimum gas-oil ratio can be determined. In Fig. 2 are plotted data taken on a well subjected to such a test. The gas and oil production and the resulting gas-oil ratio at different rates of flow are plotted against the tubing-head pressure. It will be observed that a minimum gas-oil ratio is reached at a certain point—in this case about 160-lb. pressure at the tubing head. Examination of the gas and oil production curves will show that though the oil production and the gas production continue to decline with an increase of tubing-head pressure, they do so at different rates. At pressures below that of minimum gas-oil ratio the gas production declines at a greater rate than the oil, but above the pressure of minimum gas-oil ratio the oil production drops off at a greater rate than the gas production. It is important to observe this, for it gives an insight into the reasons for gas-oil ratio changes in the well. It is the *relative* changes in the rate of decline of the gas and oil that cause the gas-oil ratio to change. It is also important to observe that two gas-oil ratios of the same size may be obtained at different tubing pressures, different bean openings, and at different rates of oil and gas production. When a restriction is imposed on the tubing flow by a flow bean the pressure at the face of the sand is changed and thus changes the rate of flow of the well.

The restriction to flow may be made by bottom-hole flow bean or surface flow bean, or both.

In applying pressure control[10] to a well the rate of daily production is sometimes reduced as much as 30 per cent or more. It used to be thought when the practice of beaning wells first came into use that unless every operator in the pool applied pressure control to his wells there would be no advantage in beaning. This reasoning, of course, is in error. In Fig. 3 the cumulative production on two offsetting wells is plotted against the number of days the wells were on production. Well No. 1 was produced under pressure control from the day it was brought in. Well No. 2 came into production about two months later and had about three times the daily rate of production of Well No. 1. The underground conditions were very similar in the two wells. Well No. 2 was never subjected to rigid pressure control. It was allowed to produce with little or no restriction. About a year after Well No. 2 had started producing the cumulative production of Well No. 1 exceeded that of Well No. 2. The restriction to flow, although it reduced the daily rate of production, in the long run had apparently increased the production from the well. At a reduced rate of flow under pressure control the flowing life was prolonged and the rate of decline less than it would otherwise have been. It is not the immediate effect on the rate of production that has to be taken into consideration but rather the ultimate effect.

It is obvious that if efforts are made to conserve the gas in the well in its early life when the pressure is high and the volume large, the savings in gas energy that can be made are much greater than if the well were allowed to produce a good part of its flush production under uncontrolled flow. These plotted data were obtained from wells under actual producing conditions. They indicate the benefits that can result from the conservation of gas by maintaining a small gas-oil ratio at wells even though an offsetting well may be producing wide open. It must be determined in a case of this kind whether or not the underground conditions are favorable by making pressure control tests at the well as outlined.

It has been found that the gas-oil ratio increases as the oil production of the well declines. There are two reasons for this: oil has to travel farther through the sand to the well and as the sand becomes depleted of oil, hence more gas energy is required to bring the oil into the hole. The reservoir pressure also declines as wells get older and at this reduced pressure it takes a greater volume of gas to bring the oil into the well.

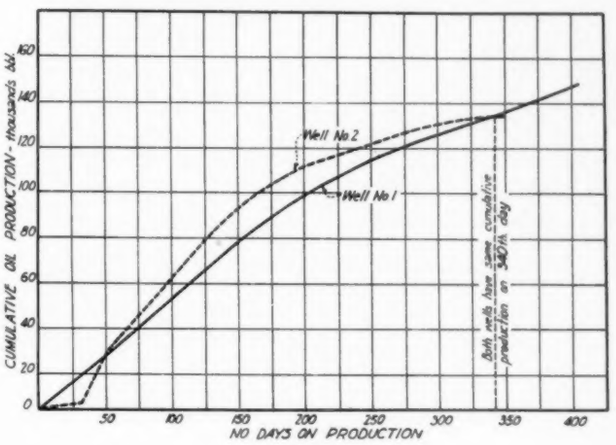

Fig. 3

Although the field man, under present conditions, is not called upon to set the maximum rate of production in flush fields, he is responsible for maintaining the allowed rate of production, which, if it falls off too rapidly through faulty control of the well, often cannot be made up, hence the desirability of knowing something of pressure control of flowing wells.

QUESTIONS

1. What governs the rate of flow of oil into the well?
2. How are the rate of oil production and the gas-oil ratio of an average flowing well controlled from the surface?
3. How would you determine the minimum gas-oil ratio of a well flowing through tubing?
   A well flowing through casing?
4. Is it always possible to obtain a minimum gas-oil ratio? Explain.
5. In an average well flowing through tubing, what would be the probable effect of excessive beaning or choking on the oil production?
   On the gas production?
   On the gas-oil ratio?
6. Why is the gas-oil ratio likely to increase as a well grows older?

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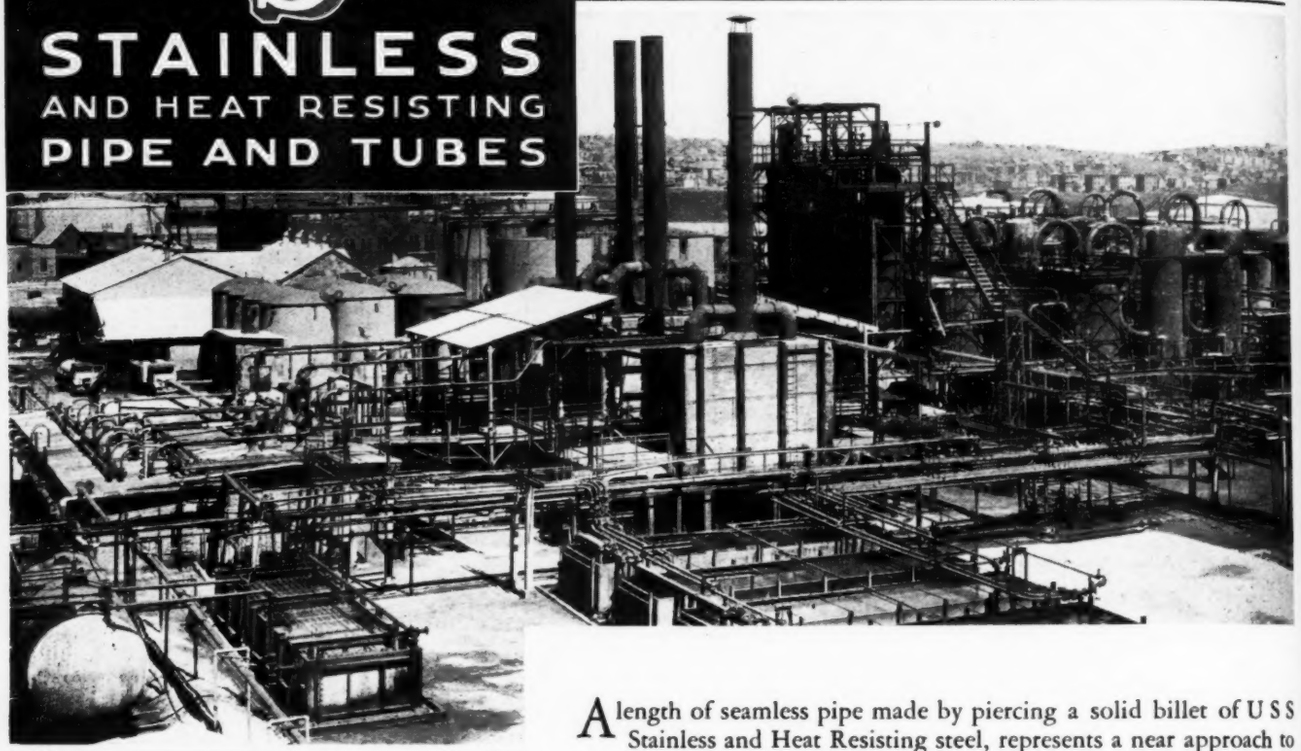

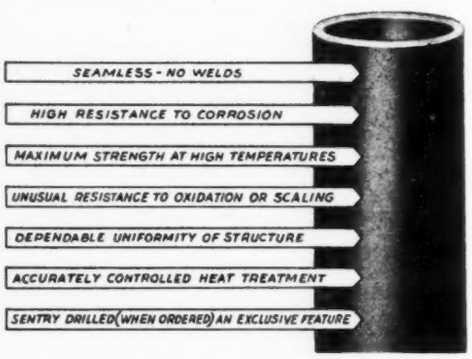
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Elements of Applied Petroleum Refining

Article II

GENERAL PROCESSING

By W. L. NELSON
Professor of Petroleum Refining
University of Tulsa

BECAUSE of the great differences in crude oils we find that a variety of processing methods are used. Safely we may say that no two plants are employing exactly the same processing scheme. What may be a perfect method of handling one oil may be inadequate for another.

Refinery Products

A study of the products of refining will help to show why so many different processing methods are used. The more important refinery products can be grouped as follows:

1. *Natural and Refinery Gas:* Household and industrial fuel.
2. *Gasoline:* Fuel for internal combustion engines.
3. *Naphtha and Benzine:* Cleaners' solvents, paint thinners and blending stocks in the manufacture of motor fuels.
4. *Kerosene:* Burning oil for lamps.
5. *Distillates and Gas Oil (distilled products):* Fuels for industrial and household furnaces, enriching agents in gas manufacture and absorbents for hydrocarbon gases.
6. *Neutral Oils:* Light or low-viscosity lubricating oil stock for the compounding of motor and lubricating oils.
7. *Bright Stock:* Heavy or high viscosity lubricating oil stock for the compounding of motor and lubricating oils.
8. *Cylinder Oils:* Unfinished heavy oil stocks, either residual or distilled, used directly for lubricating steam engine cylinders or used in the manufacture of bright stock.
9. *Paraffin Wax:* For the manufacture of wax paper, insulating materials, package sealing, etc.
10. *Petroleum Stock (non-crystalline wax):* Base material in the compounding of greases, salves, ointments and semi-solid lubricants.
11. *Fuel Oil (residual product):* Industrial fuel. (In the Pennsylvanian district gas oil is also referred to as fuel oil).
12. *Tar and Asphalt:* Road surfacing, roofing materials and protective coatings.
13. *Petroleum Coke:* Solid industrial fuel.

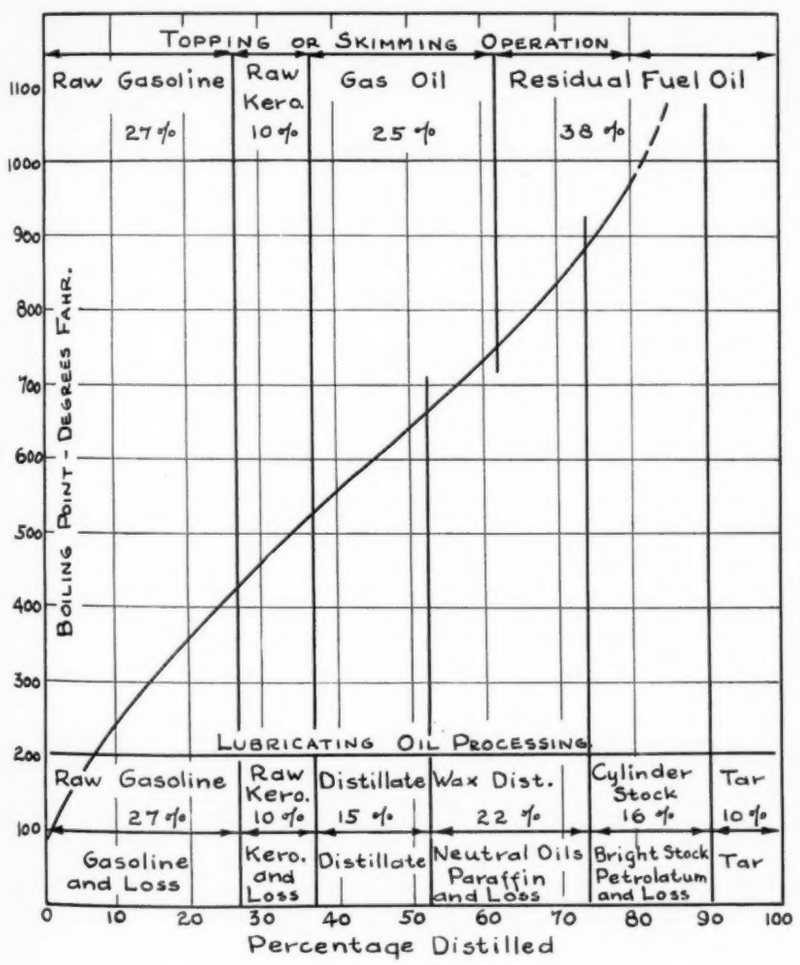


Fig. 5.—Boiling range of refinery products
[Mixed base crude oil (Tex.) 31.7 A.P.I.]

The most important method of separating the products is distillation, and hence an arrangement of the materials in the order of their boiling-ranges is useful. Fig. 5 indicates the boiling-ranges of the stocks and also shows that certain products, such as fuel oil, can be further processed and separated into other products, such as tar and lubricants. This does not mean that all fuel oils are suitable for the manufacture of lubricating oil. The lubricating oils are present, but they may be inferior products or it may cost too much to refine them.

INTERMEDIATE AND FINISHED PRODUCTS. In the refinery many other stocks than the ones mentioned above are encountered. These stocks are intermediate ones that require further processing before they are suitable for the market. Fig. 6 shows the general relation between the raw refinery stocks, the intermediate stocks, and the finished market products. As an example, gasoline at the station pump may have arrived from four sources. It may consist of (1) straight-run gasoline obtained from the crude; (2) cracked gasoline obtained by the redistillation of the pressure distillate produced by cracking; (3) natural gasoline, which is obtained from wet natural gas; and (4) naphtha, a high-initial-boiling-point gasoline, which is obtained directly from the crude oil. The dotted lines in Fig. 6 indicate cracking processing. Treating and dewaxing operations are not shown in Fig. 6.

Straight-run gasoline, naphtha and natural gasoline usually require only a sweetening treatment for the removal of hydrogen sulfide and smelly sulphur compounds; but the gasoline from certain crude oils requires an acid treatment. Raw kerosene may require sweetening, but usually no other treatment is necessary. Distillate fuels, gas oil, fuel oil, asphalt and coke, are usually sold without any chemical treatment. Pressure distillate or pressure-still gasoline may be treated with sulfuric acid and redistilled with steam, or it may be treated while still in the vapor phase, with Fuller's earth.

Wax distillate, the raw stock for the manufacture of light lubricating oils, contains crystalline wax. The wax is removed by chilling the distillate and filtering the wax from the oil in filter presses. Two unfinished stocks, slack wax and pressed distillate, are obtained in the pressing operation. Neutral oils are produced from the pressed distillate by distillation (steam or vacuum) and subsequent filtration through Fuller's earth. The slack wax contains lubricating oil as well as wax. The oil is removed by sweating; that is, by slowly warming the chilled slack wax so that the oil and low melting-point waxes, which together constitute Foots oil, melt and drain from the slack wax. The remaining hard wax called crude scale is slightly yellow in color and the coloration may be removed by treatment with caustic or by filtering the melted wax through clay.

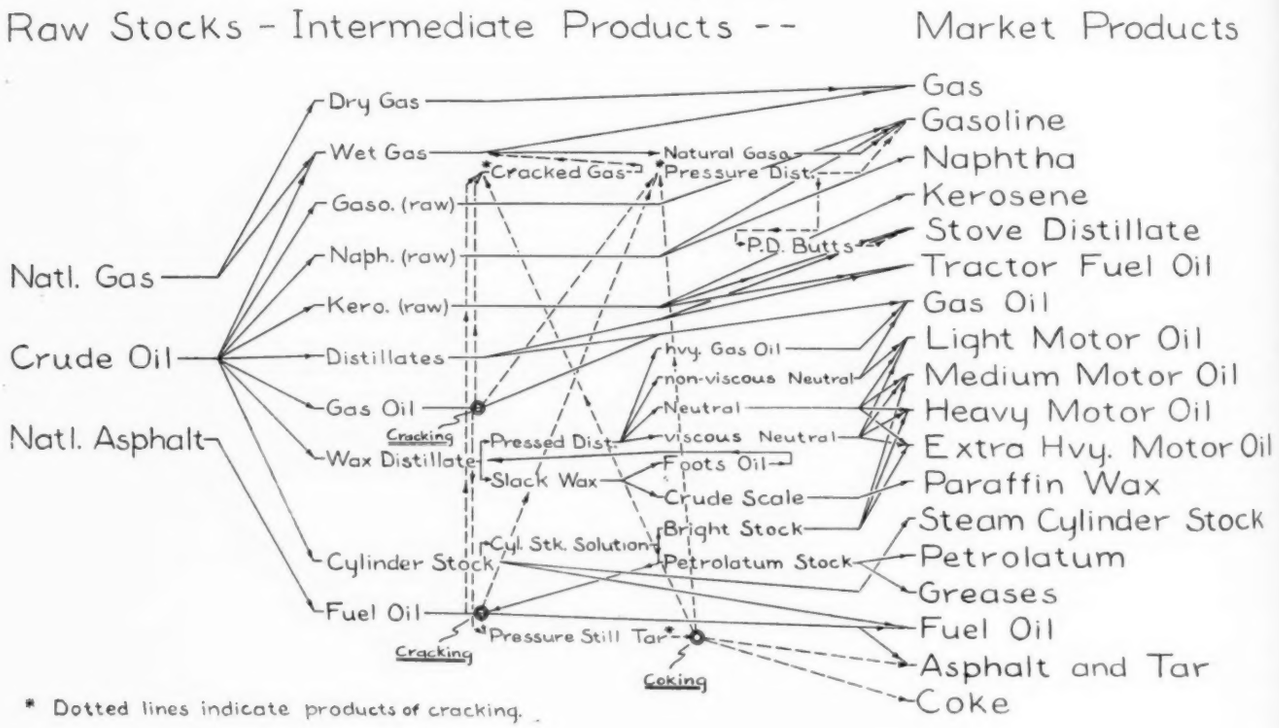
Cylinder stock is another wax-bearing product, but the wax is such that it cannot be filtered from the oil in wax presses. This so-called amorphous wax or petrolatum stock may be removed by dissolving the oil in naphtha, filtering the solution to a proper color through Fuller's earth and centrifuging the chilled solution in high-speed centrifuges. The products from this separation are bright stock solution and petrolatum stock. The naphtha is removed from the solution by distillation (with steam) leaving finished bright stock.

Cracking introduces another set of terms. Cracking-still gas, pressure distillate, cracked gas-oil or distillate, pressure-still tar and coke may be produced in a cracking operation. By cracking we refer to the decomposition of high-boiling oils into low-boiling oils by heating to temperatures exceeding 680 deg. fahrenheit. In most cracking systems an intermediate boiling-range product called recycle stock is produced and this stock is recycled through the cracking still. It never appears as a final product of cracking because it is continually being used up in the cracking system. Recycle stock has about the same boiling range as gas oil.

Types of Processing

In general, the refining of petroleum is carried out as outlined above. Crude oils, however, vary widely in their properties and some oils may not contain all the above products or may contain them in such small quantities that the manu-

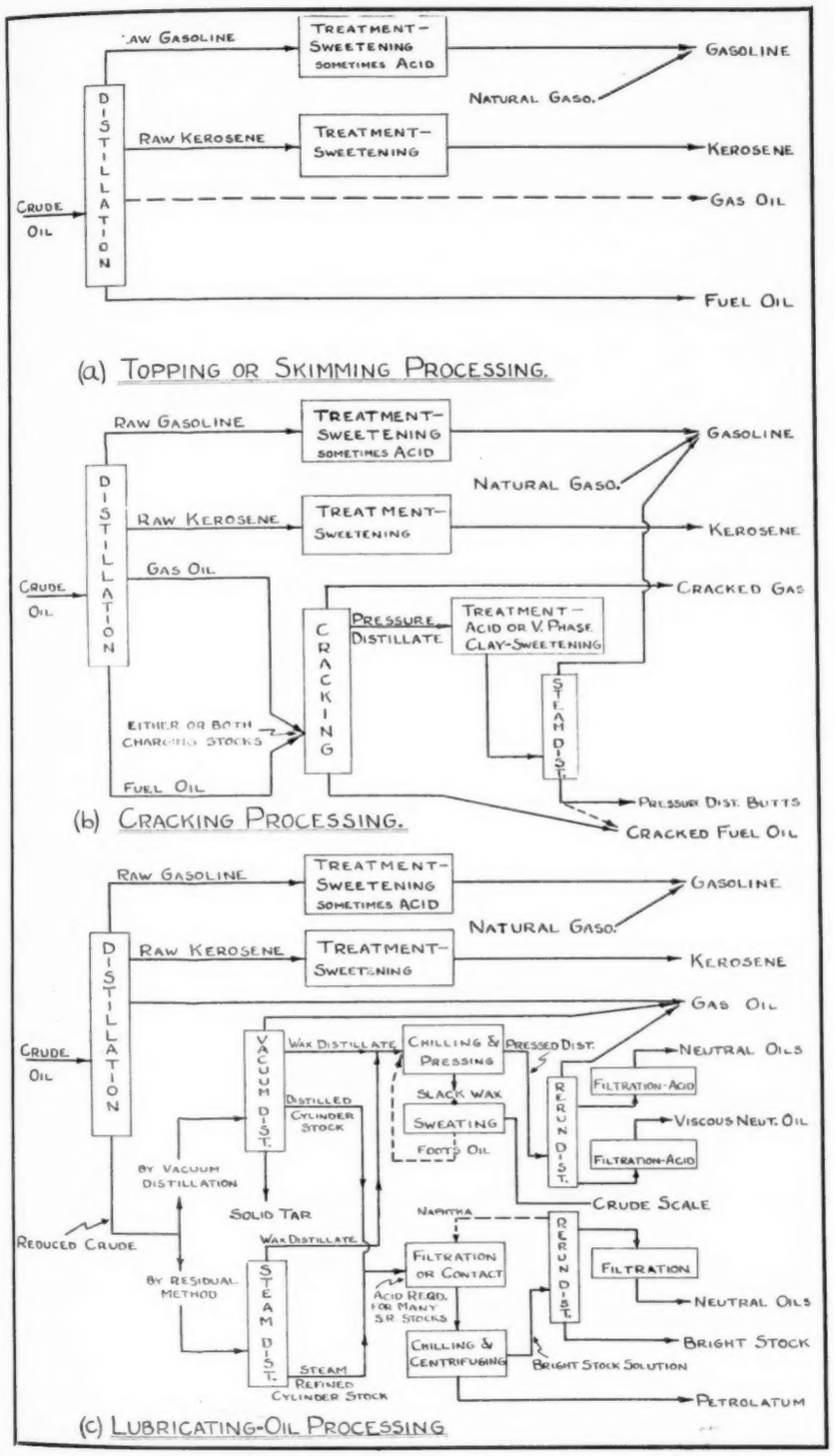
Fig. 6.—Refinery products



* Dotted lines indicate products of cracking.

facture of them is not profitable. Likewise, certain oils are inherently better suited for refining and may not need the treatment as outlined, while others may need even a more vigorous chemical treatment. Still further, the particular market conditions of the refiner are an important factor in governing the extent of the refining operations. Certain localities have become accustomed to using discolored gasoline, while others demand white gasoline and still others prefer a dyed gasoline. These and many other factors cause refinery processes to differ widely. The industry, however, has adopted several general types of processing.

Fig. 7.—Types of refinery processing



SKIMMING OR TOPPING. This is a simple distillation of crude oil in which gasoline, kerosene, fuel oil and sometimes gas oil, are produced. Topping is extensively practiced on mixed and naphthene-base crude oils. [See (a) Fig. 7].

CRACKING. This usually refers to a combined operation of topping and cracking. The customary products are straight-run and cracked gasoline, straight-run kerosene, cracked fuel oil, and sometimes furnace distillates and coke. All bases of crude oils are cracked, but the residual stocks from paraffin-base oils are seldom cracked, because of the valuable lubricants that they contain. [See (b) Fig. 7].

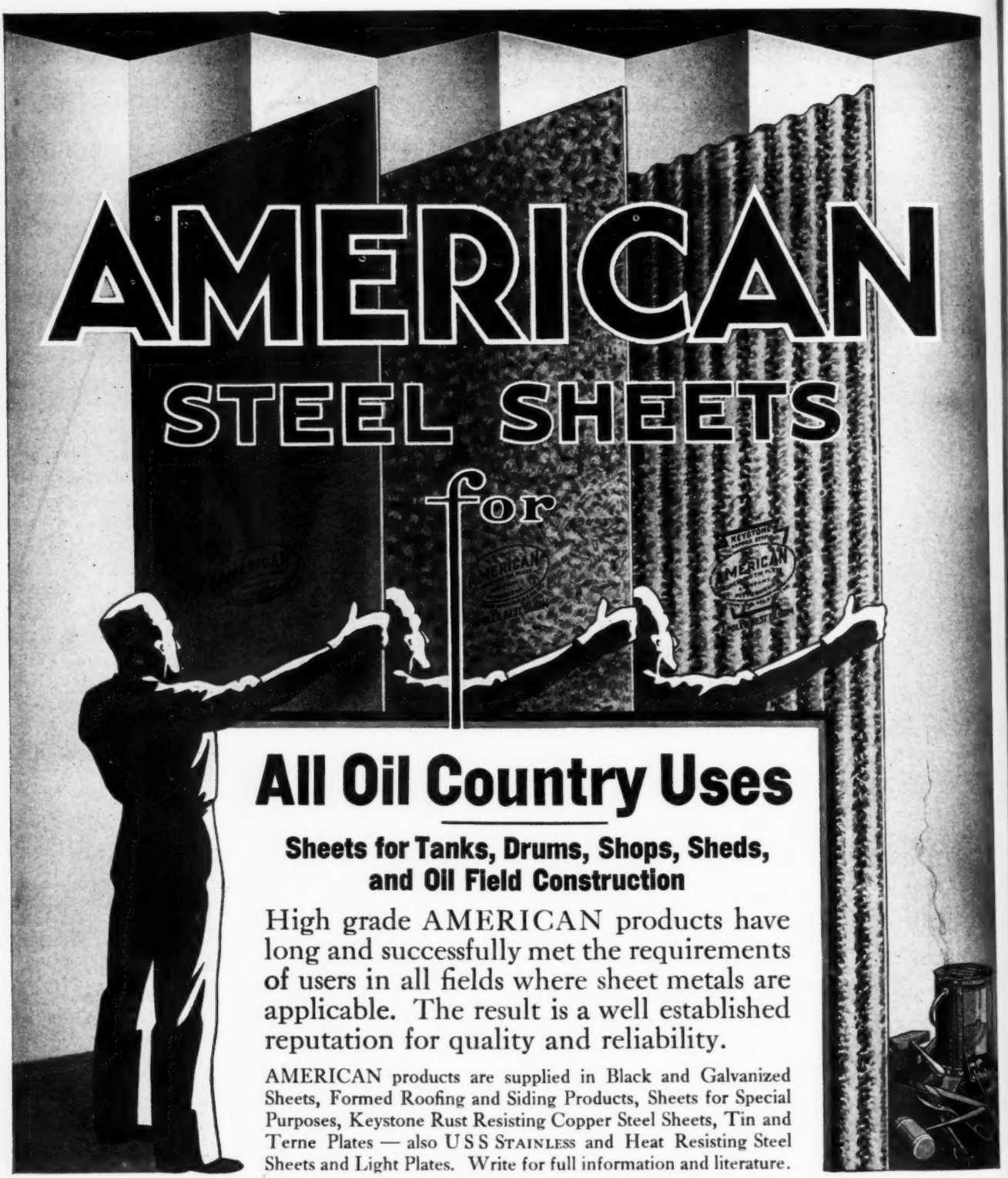
LUBRICATING OIL PROCESSING. This consists of topping the crude oil and further processing the residue into lubricating oils. Paraffin-base oils are almost always processed thus. Mixed-base oils are often processed for lubricants, but naphthene-base crude oils are not processed for lubricants unless the crude oil and market conditions are particularly favorable. [See (c) Fig. 7].

COMPLETE PROCESSING. This consists of topping, cracking and the manufacture of lubricating oils, and is practiced by most of the larger companies. The large refiner often has several crude oils; the best of these are processed for lubricants and the others are cracked.

●

Questions

1. What refinery stocks are used in compounding motor oils?
2. Distinguish between pressure distillate and pressed distillate?
3. Do furnace distillates and gas oil usually require treatment with sulfuric acid?
4. Fuel oil and gas oil are both burned as a fuel. What is the major difference between them?
5. Arrange gasoline, furnace distillate, wax distillate, kerosene and cylinder stock in the order of their boiling-ranges.
6. Why are two different methods of dewaxing used?
7. Locate wax distillate, crude scale, pressed distillate, slack wax and the neutral oils in the processing scheme.
8. Name three materials that may be a part of gasoline.



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Vocational Refinery Mathematics

Article II

By P. ALBERT WASHER

METERING DEVICES

Calculation of Flow and Pressure Drop

PRACTICALLY every refinery employe is confronted with problems of flow calculations. The stillman must keep accurate readings on the charge to the battery, the topman should know the amount of wash or reflux being fed to the towers, and the pumper must know the rate at which the run-down tanks are being filled. Bearing this in mind, it is readily observed that a knowledge of measuring instruments is very essential.

The most important metering devices in the refinery as far as calculations are concerned are of the velocity type. That is, they determine the speed of the fluid passing a certain point. If the area through which the fluid is passing is known and the time of passage is determined the volume may be found. Meters of the velocity type in order of their simplicity are as follows:

1. Standard Orifice.
2. Venturi.
3. Pitot tube.
4. Anemometer.

Other methods of determining flow rates used frequently are:

5. Weirs.
6. Heat balance.

The flat plate orifice and the Venturi tube work on the principle that if an orifice or constriction is introduced into a pipe through which a fluid, either liquid or gas, is flowing the pressure of the fluid ahead (upstream pressure) of the orifice or constriction is greater than the pressure immediately behind (downstream pressure) and that the difference in pressure for a given set of conditions varies with the rate of flow. In case of the Pitot tube the difference in pressure is due to the impact of the fluid on the mouth of one branch of the U-tube whose ends are inserted into the line of flow.

The general formula for flow of a liquid through an orifice is:

(17) $V = 327.2\ d^2\ Ft\ Fg\ E \sqrt{h}$

in which

V = Rate of flow in gal. per hour.

d = Diameter of orifice in inches.

Ft = Correction factor for temperature obtained as follows:

(18) $Ft = Gf/Gb$

where

Gf = Sp. gravity of liquid at storage temperature.

Gb = Sp. gravity of oil as it passes through orifice.

(19) Fg = Correction factor for gravity, obtained thus:

$$Fg = \sqrt{(1 - 0.0737)Gs/0.9263\ Gf}$$

where:

Gs = Sp. gravity of sealing liquid or liquid in contact with mercury. (Water at 60 deg. fahr. is 1).

Gf = Sp. gravity of flowing liquid (Water at 60 deg. fahr. = 1).

E = Orifice efficiency. This is a function of d(orifice dia.)/D(pipe dia.)

Naturally, E varies with d/D and ratios of more than .75 are not recommended. Values of E are given in Table I for flange connections, as follows:

TABLE I

d/D	E	d/D	E	d/D	E
.05	.5985	.30	.6035	.55	.6403
.10	.5990	.35	.6065	.60	.6580
.15	.5996	.40	.6110	.65	.6815
.20	.6004	.45	.6176	.70	.7119
.25	.6016	.50	.6271	.75	.7505

h = Differential pressure existing between the two pressure connections expressed in inches of water head. It can be determined by several methods. One of these is reading a chart (L-10 or M.O.) on which the record is kept constantly.

If the chart is the "L-10" (10 major divisions), as is invariably the case, and the meter is a 100-in. the reading represents the square root of the differential in inches of water.

As an example: Suppose we had a corrected coefficient of 20,000 obtained from $327.2\ d^2\ Ft\ Fg\ E$ and a reading of 7.0 on the "L-10" chart the flow would be simply:

$$20{,}000 \times 7.0 = 140{,}000 \text{ gal. per hour.}$$

Now, if the meter is smaller than 100-in. use the following formula:

(20) $Q = C \sqrt{S/100 \times R^2}$

Q = Flow rate in gal. per hour.

S = Size of meter in inches.

R = Reading on the "L-10" chart.

C = Corrected coefficient. From: $327.2\ Ft\ Fg\ E$.

Thus, Given: 50-in. meter, reading on "L-10" = 7.0 and C = 20,000. Required: Flow rate.

Solution:

$$Q = 20{,}000 \sqrt{50/100 \times 7^2} = 20{,}000 \sqrt{24.5} = 99{,}000 \text{ gal./hr.}$$

The "M.O." chart reads directly in inches of water head and it is, therefore, necessary to extract the square root of the differential, h.

Now, in case there is no recording chart it is often necessary to obtain the differential head as the difference of two pressures by the use of a manometer (U-shaped differential gauge). It is convenient to employ in the lower part of the tube a liquid that is immiscible with the one flowing and of higher specific gravity. The desired difference in head equals the difference between the mercury-liquid levels of the two arms multiplied by the ratio:

(21) $(y\text{-}s)\ (s)$,

where y and s are the specific gravities of the heavier and lighter liquids, respectively.

Thus, if an oil head is being measured by mercury (Hg) in a vertical U-tube, the oil filling the rest of the tube, the oil head will be (assuming s = .9) the observed difference in mercury levels multiplied by (13.6 — .9) (.9) or 14.1.

For water the general formula (17) boils down to:

(22) $Q = 327.2\ d^2 \times E \sqrt{h}$

To obtain the coefficient for the Venturi throat the following formula is employed:

(23) $C = 324\ d^2/\sqrt{1 - x^4}$

in which d = diameter of throat in inches.

x = ratio of throat diameter to pipe diameter.

Viscosity effects may safely be neglected provided the quantity:

(24) Vb/dts

when computed is more than 332, where

Vb = flow rate in gal. per hour.

d = diameter of orifice in inches.

ts = 455 × kinematic vis. in C.G.S. units (approximately same as vis. in Saybolt-Universal sec. at actual flowing temperature for viscosities above 195).

An example using the general formula is cited below.

Given: Orifice 2.375 in a 6.065-in. line.

Gravity of flowing liquid 42 deg. A.P.I. at 60 deg. fahr. Sp. gravity .8155.

Flowing temperature, 60 deg. fahrenheit.

Storage temperature, 60 deg. fahrenheit.

h, 64 inches.

Required: Rate of flow in gal. per hour.

Solution:

$d^2 = (2.375)^2 = 5.62$

$Ft = 1.0$

$Fg = \sqrt{1-(.0737\times.91)/(.9263\times.815)} = 1.115$

$d/D = 2.375/6.065$; therefore E = 0.61

and:

$V = (327.2)\ (5.62)\ (1.115)\ (1)\ (0.61)\ \sqrt{64}$
$= 10{,}000$ gal. per hour.

Weirs. The importance of weirs in the refinery is quickly realized when observing condenser box overflows. The majority of the boxes are equipped with "practical" weirs, that is, weirs at which measurements may be made as though the notch were a true weir for all practical purposes. As a rule, the rectangular weir is the most common type in the plant. The Francis formula is used for calculations of this type.

(25) $Q = 3.33\ (b - .2H)\ H^{3/2}$

in which:

Q = Cu. ft. per second.

b = Breadth in ft. of the notch or length of the weir.

H = The head in ft. above the crest measured by the hook gauge. This can be obtained by simply setting the hook gauge accurate with the water level just at the crest of the weir and point of hook showing above the water.

Other types of weirs include the triangular and the trapezoidal.

For a triangular weir:

(26) $Q = 4/15\ c\ b\ H^{3/2}\sqrt{64.4}$

where c is the coefficient of contraction.

(27) Or, $Q = 2.53\ H^{3/2}$ for a right-angled notch.

For a trapezoidal weir:

(28) $Q = 3.367\ b\ H^{3/2}$ cu. ft. per second.

This type is used in measuring small quantities of water and requires no correction for contraction.

In order to provide practice in solving the different weir formulae and have figures for actual field use, the values in Table II were calculated:

TABLE II

(For Rectangular Weir)

Head in inches	Head in feet	Gal./min./ft. of weir length
¼	.021	4.49
½	.042	12.64
¾	.062	23.10
1	.083	35.40

Since water is a very important item in the refinery a fairly accurate check is kept of its use. As a rule, the total quantity is measured to the unit by a master meter (Venturi orifice), while other methods are necessary to measure the consumption on the individual condenser boxes. Where there are no weirs a simple heat balance can be used.

(29) $Q = [PW(T_1 - T_2)s/8.34(T_3 - T_4)] \times 24$

where:

Q = Water flow in gal. per day.

P = Product in gal. per hour.

W = Weight of product in lb. (see Tag Manual).

s = Specific heat of product (see formula 14, Art. I)

T_1 = Temperature of oil to condenser.

T_2 = Temperature of oil from condenser.

T_3 = Temperature of water from condenser.

T_4 = Temperature of water to condenser.

Example:

Given: P = 1527 G.P.H. A.P.I. gravity = 25.5

W = 7.505 s = .56

T_1 = 370 T_3 = 188

T_2 = 205 T_4 = 75

Solution:

$(1527\times7.505)\ (370-205)\ (.56\times24)/8.34\ (188-75)$
= 27,000 gal./day.

In cases where there are no orifices, throats or meters available, the rate of flow of a liquid being pumped through a line may be determined from the total head on the pump (how to determine this total head will be outlined in Article III, to appear next month). Then, by referring to the characteristic curve (also to be given in Article III) and noting where the total head or ordinate intersects the head-capacity curve, the abscissa will represent the approximate rate of flow.

Gas Formula. The simplified formula for measuring gas flow is as follows:

(30) $Q = C\sqrt{h\,P}$

in which:

Q = Quantity in cu. ft. an hour at the base pressure, base temperature, and flow conditions at which the value of the hourly coefficient, C, has been determined.

h = Differential in inches of water (obtained as outlined previously).

P = Line pressure in lb. per sq. in. absolute. It is equal to the gage pressure plus atmospheric pressure. (A full explanation will be given in Article V of this series).

C = Coefficient corrected for temperature and gravity.

Steam. The flow of steam through an orifice depends only upon the initial pressure and quality of the steam and is independent of the pressure beyond the orifice (downstream pressure) provided the latter is less than 55 per cent of the initial pressure. The formula that expresses the amount of steam flowing, W, in lb. per sec. is:

(31) $W = 0.3155\ A\ P_1\ V_1$

in which:

A = Area of orifice in sq. in.

P_1 = Absolute pressure of steam in lb. per sq. inch.

V_1 = Volume of one lb. of steam at the pressure P_1.

Since for dry saturated steam, the ratio $P_1/P_1\ V_1$ is approximately constant at 20.9, between 50 and 100 lb. per sq. in. absolute pressure, a simplified expression of the above formula is:

(32) $W = 0.90\ A\ P_1$

in which:

W = Lb. of steam flowing per minute.

Since in this approximation P_1 is the only variable on the right of the equation it is readily seen that for a given orifice a steam pressure gauge measuring the pressure at the inlet of the orifice may be calibrated to read lb. of steam flowing per minute.

Where there is no meter at the unit, steam flow may be calculated by a heat balance (as will be outlined in Article V).

Pressure Drop. Closely connected with the subject of flow is pressure drop through lines and other equipment as heat exchangers, and the like. The most useful formula in the refinery for this purpose is the well-known Fanning equation.

(33) $\Delta p = 2\ L\ e\ u^2\ f/144gd$

where

L = Length of straight pipe, in ft., plus equivalent length due to bends, valves, and other connections.

e = Fluid density in lb. per cu. ft. = 62.3 × s.

u = Average velocity of the fluid in ft. per sec. = Discharge in cu. ft. per sec./cross section in sq. feet.

g = 32.2 ft. per sec. per second.

d = Actual inside diameter in feet.

Δp = Pressure drop in lb. per sq. inch.

D = Actual inside diameter in inches.

s = Sp. gravity, no units.

Z = Viscosity relative to water at 68 deg. fahr.

f = Friction factor, no units. Obtained from D u s/Z. (See Table III).

TABLE III

D u s/Z	f	D u s/Z	f	D u s/Z	f
.01	0.2	.5	.013	25	.0050
.02	0.1	.9	.010	40	.0046
.05	.040	1.0	.0098	50	.0045
.07	.300	5.0	.0063	75	.0044
.1	.0207	7.0	.0060	80	.0043
.2	.0150	10.0	.0058	100	.0042
.3	.0140	20.0	.0055	200	.0040

A typical application of the Fanning formula to find the pressure drop is given below. The difference in pressure drop, hence, power consumption, for oils of different viscosities is clearly shown in this problem.

Example: What is the pressure drop in lb. per sq. in. of horizontal 6.07-in. steel pipe when pumping 1000 bbl. of oil per hour if the Saybolt viscosities are 231 and 2140 respectively? (s = .9 and 42 U.S. gal. = one barrel).

Solution: Use formula (7) to obtain Z/S = 50.

The average velocity through the pipe is:

$(42)(100)/[(3600)(7.48)(6.07)^2(.785)/144] =$ 7.77 ft. per second.

The value of Dus/Z = $(6.07)(7.77)/50 = 0.943$.

Therefore f = .010.

The pressure drop per mile =

$(2)(.010)(5280)(62.3)(.9)(7.77)(7.77)/[(32.2)(6.07)/(12)(144)] = 152$ lb. per sq. inch.

For a viscosity of 2140:

Z/S = 470.

Then Dus/Z = $(6.07)(7.77)/470 = 0.100$.

Therefore, f = 0.0207. (See Table III).

The same general equation is used as before, even though the type of flow is now straight-line instead of turbulent, and hence the pressure drop is:

Press. drop = $152(0.0207)/(0.0100) = 315$ lb. per sq. in., which is 107 per cent higher than in the the first instance.

How to calculate the theoretical horsepower required to overcome these pressure drops will be taken up in the next article.

Richard J. Berry, Ohio Oil Executive, Dies

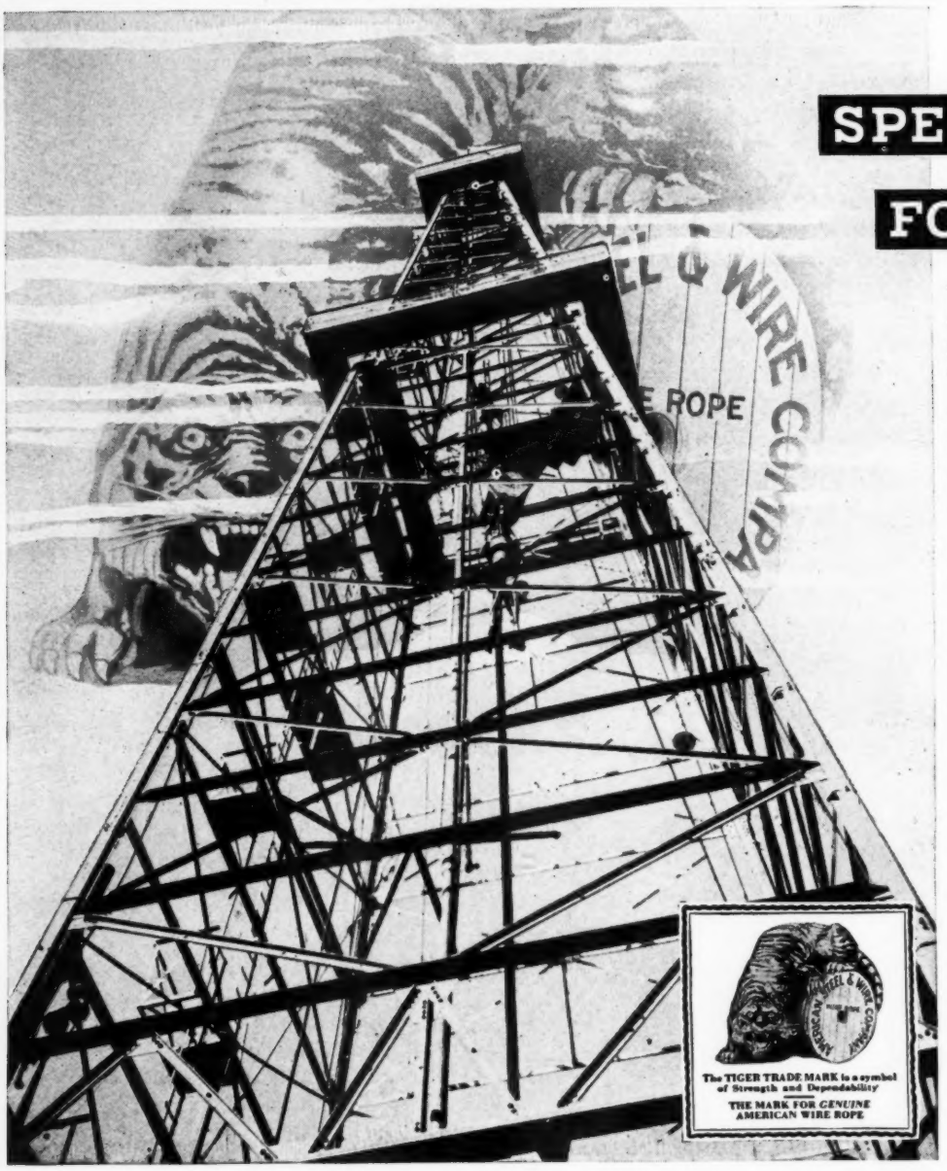
RICHARD J. BERRY, vice-president of the Ohio Oil Company, died recently in Fort Worth, Texas, of a heart attack. Mr. Berry, for many years a prominent figure in the petroleum industry, expired within 15 minutes. Mr. Berry, a resident of Findlay, Ohio, and for many years a prominent figure in the petroleum industry, was in the Mid-Continent territory on a business trip at the time of his death.

He was born in Oil City, Pa., in 1873, and moved to Findlay in 1892. At that time he became stenographer for J. C. Donnell, late president of the Ohio Oil Company, and served continuously with the company in many different capacities until his death. The company had been in existence only five years when he became a member of the organization and as it expanded he advanced steadily, being made a member of the directorate in 1906 and vice-president in 1923.

Mr. Berry was also president of the Mid-Kansas Oil & Gas Company and the Illinois Pipe Line Company, subsidiaries of the Ohio Oil Company. He became head of the Mid-Kansas organization in 1916 and later was elected to the same position with the pipe line concern. He also was president of the Ohio-Mexico Company and vice-president of the Western Public Service Corporation.

In 1902 he was married to Miss Marie Dodge of Columbus, Ohio, who survives. Additional survivors are a sister-in-law, Mrs. Charles Berry of Hartford, Conn., and two nephews, Charles and William Berry.

WHAT'S BACK OF WIRE ROPE IS VITAL



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Operation of Stock Motors At Multiple Voltages

By W. C. LANE
Electrical Engineer

CHANGING the operating voltage of an induction motor does not alter its speed materially, though it does modify its other operating characteristics. When motors are operated at less than their rated load it is possible to increase both their efficiency and power factor by subjecting them to a lower voltage than that for which they are designed. Such load conditions are likely to arise in any oil field. The East Texas field under proration is a good example. In this field such wells as have stopped flowing and have been equipped for pumping require a comparatively small amount of power to lift the production allotted. Since it is the consensus of opinion that within the life of the field the power demand will increase to several times that existing now, overmotoring is the prevailing practice.

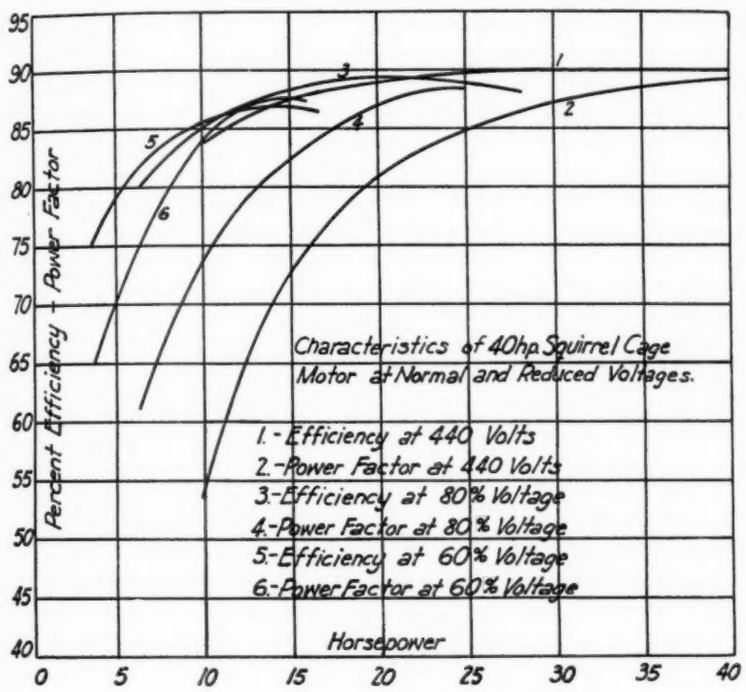

Fig. 1

The curves given in Fig. 1 show the efficiency and power factor of a standard 40-hp. squirrel cage motor when it is operated at its rated voltage and at 80 per cent and 60 per cent of its normal voltage. The load limits shown on the curves will be found to be about the same as those determined by calculation, the principle involved being that the power a motor will develop is proportional to the square of the voltage impressed over it. In reality the exact rating at a reduced voltage is based on the load at which the speed will fall to the lowest value permitted by standard practice. It is obvious from the curves that when loads are much below normal, both the efficiency and the power factor are improved as a result of a reduction in voltage. The effect on the power factor is more pronounced than it is on the efficiency. It appears that many times under actual operating conditions found in a pumping field it would be advantageous to reduce the voltage as much as 40 per cent. It is possible to provide multiple voltage by running more than one secondary circuit over the field. This method is not recommended, as special transformers must be used; it is inefficient, is somewhat cumbersome, and is expensive to install. A better way to procure more than one voltage is to set an individual transformer bank at each well. This is the more efficient, but the cost of the installation appears to be unnecessarily high. The objections to these two methods have been partially obviated by the use of multiple-rated motors. Multiple ratings are procured by changing the connections so that different voltages are impressed over the phase windings. In reality this is another way of varying the voltage over a motor. The characteristic curves will be found to be identical to those obtained by varying the voltage at the terminals. That this is true is obvious from the following discussion.

In Fig. 2, "a" represents diagrammatically a Delta-connected motor, A, B, and C being the phase windings. The full line voltage will be impressed over each phase and evidently the maximum rating will exist when this connection is used. The Star grouping is represented by "b." Each phase in this figure will be subjected to the line voltage divided by the square root of three. For a 440-volt oil field motor the numerical value of this quantity is 254 volts. Evidently when this connection is used, at a given rotor speed, less current will flow through the winding than will flow when the Delta connection is used so that less torque will be produced. The capacity will be the same in "b" as that which will exist when the connections are as in "a" and the pressure is reduced to 254 volts. The intermediate rating of a triple-rated motor corresponds to about 80 per cent of the normal line voltage.

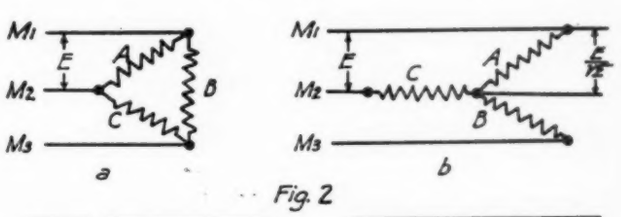

Fig. 2

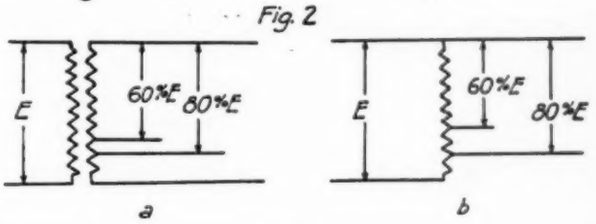

Fig. 3

In calculating the voltage at which a given motor will produce a certain horsepower the principle involved is that stated elsewhere; that within operating limits, the horsepower of a motor is proportional to the square of the voltage. For example, suppose a 440-volt 25-hp. stock motor is carrying only one-half its rated load and it is desired to give it the

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THE NATIONAL SUPPLY COMPANIES

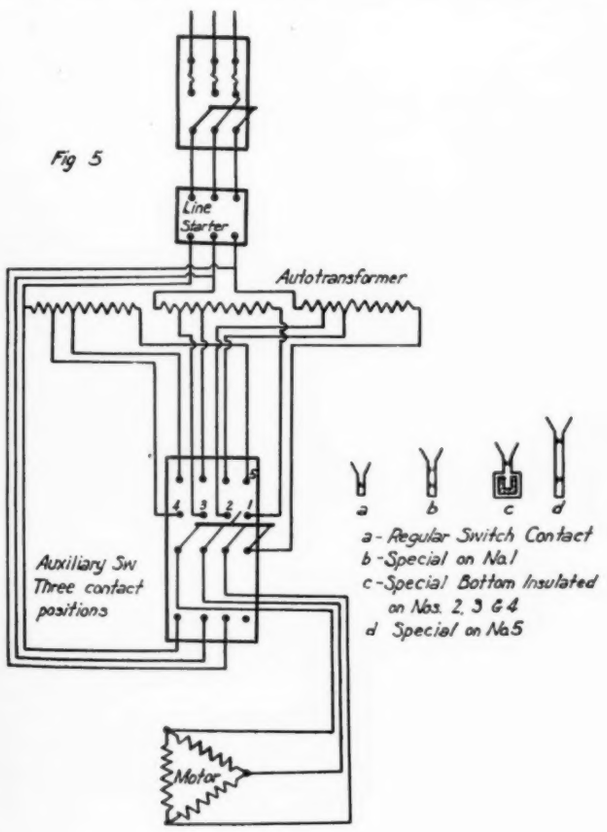
characteristics of one whose rating is 12.5 hp. The voltage to be used, E′, is:

$$E^2/440^2 = 12.5/25 = 331 \text{ volts.}$$

For those who wish to standardize on a single motor having a maximum capacity sufficient to operate wells under the most extreme conditions likely to be encountered, it appears that the multiple-rated motor is the most economical type to use. In case an operator does not wish to install multiple-rated motors or has in stock used single-rated motors of the desired maximum capacity, it is possible to obtain the same results by operating them in conjunction with auto-transformers. As far as the writer is able to learn this method has not been used in an oil field, but there is no reason why it will not work satisfactorily and efficiently.

An auto-transformer is a special type of transformer such as is used for starting large induction motors in which one winding is used for both the primary and the secondary. In Fig. 3, "a" represents the arrangement of the coils on a standard transformer and "b" the connections of an auto-transformer. The advantage of the latter over the former is that its capacity for supplying energy to a given load is proportional to the *change* in voltage while the former must be large enough to transform all the power supplied to the load. In other words, if the capacity of a bank of transformers necessary to operate a 40-hp. motor on 80 per cent normal voltage for carrying a 25-hp. load is 25 kva., the capacity of an auto-transformer necessary to perform the same duty is 20 per cent of 25 kva. or five kva. Assuming an efficiency of 98 per cent for a 25-kva. transformer and 97 per cent for a 5-kva. auto-transformer, the loss in the former will be two per cent of its capacity and in the latter three per cent of its capacity. Obviously the actual power loss in the auto-transformer is less than one-third that in the transformer; also, its first cost will be much less.

It appears that the better practice is to use a three-phase auto-transformer rather than to use three single-phase units for each installation. Table 1 gives the approximate motor ratings that can be obtained by operating on different voltage



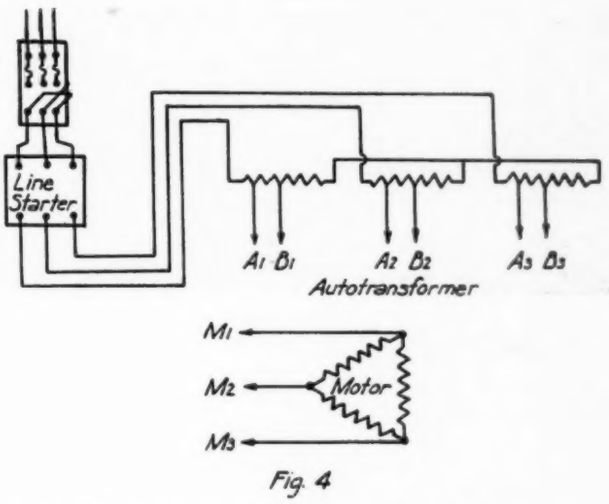


Fig. 4

taps, and the auto-transformer capacity for the worst condition arising. Since existing standards do not include the capacities calculated, 5-kva. and 7½-kva. auto-transformers should be specified.

TABLE 1

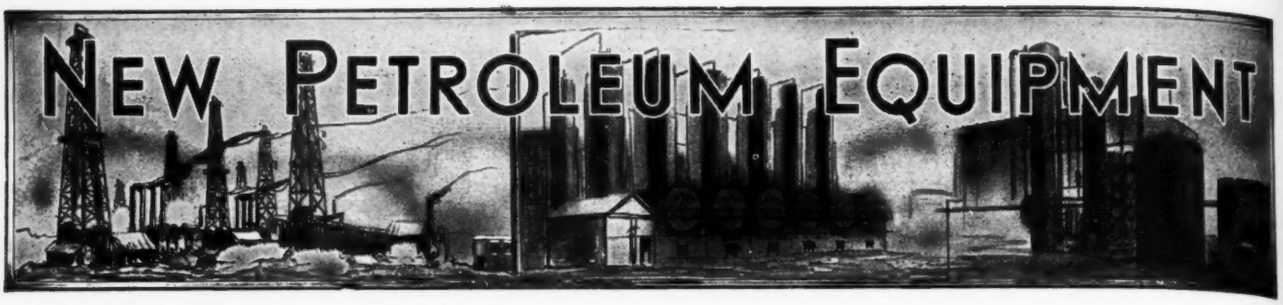
Normal Rating of Motor	Per Cent of Full Voltage—Hp.				Auto-Transformer Kva.
	80	70	60	50	
25-hp.	16	12	9	4	4
40-hp.	25	20	15	6	6

It will be found that the maximum auto-transformer capacity will be required when a motor is to be operated at about 66 2/3 per cent of its normal voltage. In practice it does not appear that there is much advantage gained by using more than two intermediate voltages unless the load becomes very small. The advisability of operating a motor at a greatly reduced voltage is questionable as conditions are very unstable when this is done. In fact, as far as efficiency only is concerned, a study of Fig. 1 leads to the conclusion that a 70 per cent tap for all conditions below a 20-hp. load is probably all that is needed for the 40-hp. motor.

It is a simple matter to arrange the wiring so that multiple voltages may be utilized. Fig. 4 shows how this can be done at the terminals of the auto-transformer. All that is necessary to do in order to obtain a desired rating is to connect the motor leads M_1, M_2, M_3 to A_1, A_2, A_3, B_1, B_2, B_3 or directly to the line starter when the maximum rating is required. When the last connection is used the auto-transformer connections should be disconnected from the line starter in order to eliminate the no-load auto-transformer losses.

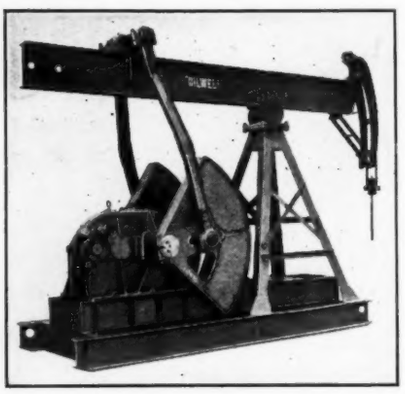
In case one wishes to be able to switch from one rating to another without disturbing the wiring it is possible to do so by using a plug switch, a drum-type switch or a simple knife switch. Fig. 5 shows the connections when a triple-contact, four-pole switch is used for three ratings. The special jaws indicated for the auxiliary switch have been developed for other purposes so will add but little to the cost of a standard switch assembly.

The cost of an auto-transformer for operating a 40-hp. motor at 80 per cent and 60 per cent voltages at the ratings corresponding to these voltages is approximately $85 and one for use with a 25-hp. motor $70. The auxiliary knife switch outlined in Fig. 5 should cost about $25. It appears that the method will be particularly valuable to use on old pumping installations that are found to be overmotored as a result of the natural decline in production. An auto-transformer may be inserted in the circuit as in Fig. 4 at a nominal cost for wiring and can be moved from location to location as needed.



Twin-Crank Unit Power

OIL WELL SUPPLY COMPANY, Dallas, Texas, has placed on the market a twin-crank unit power that is designed for efficient pumping of an individual well. The 18-in. CB-section walking beam is mounted on the sturdy



structural steel base. Mounted also on the base is an oilbath, roller-bearing equipped Westinghouse-Nuttall TC-20 double reduction gear unit with silent helical gears and twin counterbalanced cranks. It actuates the walking beam through two pitmans and a pitman equalizer. The bearings at top and bottom of each pitman are self-aligning, and the load is equalized on the top of the cranks at all times.

Each counterbalanced crank has 17 pockets, and lead weights are placed in these pockets to provide the necessary lag or lead for effective counterbalancing.

The recommended maximum pumping speed is 28 strokes per minute, and speed changes are made with the V-belt drive. Maximum recommended polish rod load is placed at 14,000 pounds.

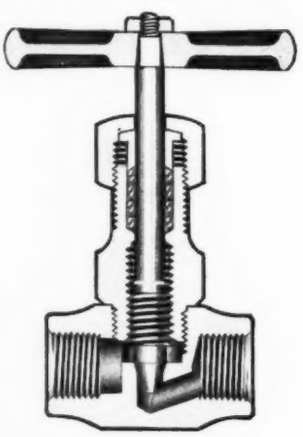
Oxweld Pipe Cutting Machine

ANOTHER new cutting machine, known as the Oxweld Pipe-Cutting and Beveling machine, has been announced by The Linde Air Products Company, 30 East 42nd St., New York. It consists of a center rod with three spreading arms that press against the inner wall of the pipe, holding it in position, with an arm supporting a blowpipe that can be adjusted to the desired angle of the cut. The blowpipe and arm rotate without the use of a crank for quick centering of the device, and by means of a crank when doing actual cutting.

This machine will take almost any hand-cutting blowpipe, is readily portable, and its operation is extremely simple. Once centered in the pipe, the operator merely turns the crank, causing the blowpipe to rotate evenly around the pipe, making a clean machine-like cut.

High-Pressure Needle Valves

CRANE COMPANY, 836 South Michigan Avenue, Chicago, Ill., has placed on the market a newly-designed line of high-pressure needle valves that have been made as small and compact as possible without sacrificing efficiency or quality. Made from carbon steel or exelloy (a high chrome, stainless iron) their sturdy, rugged construction makes them suitable for service in all industries where measuring pressures or



volumes of flow of fluids or gases is done, and where a very gradual release of pressure is necessary to prevent damage to such delicate instruments as pressure gauges and meters.

Particularly adaptable to high-pressure gauge lines on oil service, these valves can also be used on water or gas lines, orifice meters, regulator leads and by-pass connections in power, industrial or chemical plants, in refineries, or on gas and gasoline distributing systems where high pressures at relatively low temperatures are encountered.

These valves have many practical improvements such as long pipe threads, long stem threads with liberal engagement in all positions, unusually deep stuffing-box with gland, tight metal-to-metal bonnet joint, long tapered plug disc and extra long bonnet thread.

Velvo-Grip Tools

THE VELVO-GRIP VISE and wrench shown here have recently been placed on the market by Wolverine Industries, of Harbert, Michigan. It is claimed by the manufacturer that when properly used, these tools will hold any

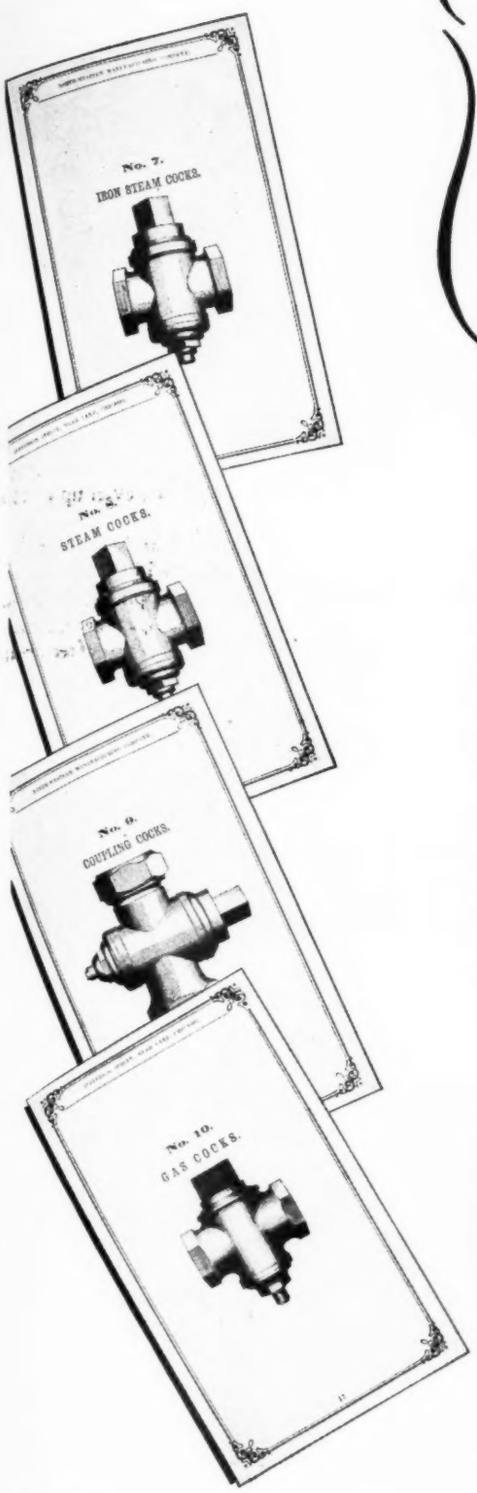
material without scratching, crushing, or in any way injuring it.

Each tool employs the principle of cushioning its grip on materials by the use of wood jaws that grip the full surface of the material. Jaws are interchangeable in vise and wrench and are made of standard two by four lumber. They are treated to prevent checking or shrinking, lock in position when pressure is applied and release when tapped lightly.

The vise consists of a two-part malleable iron frame, a set of cushion jaws for standard size materials and a screw yoke. The lower part of the frame forms the base. In one end of this base is pivoted the screw yoke and to the other is hinged the upper half of the frame.

The wrench also has a two-part frame, but depends on a cam action for its grip. The handle is so placed with relation to the two halves of the frame that the greater the pressure applied on the handle, the tighter the material is gripped.

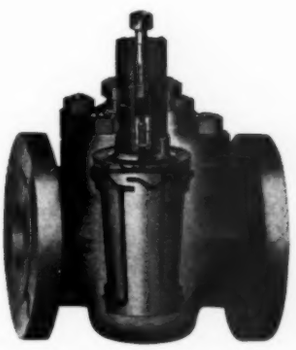
67 Years Ago Crane Built "plug valves"



The old adage, "Experience is the best teacher," applies to most things including the manufacture of valves.

Reproduced here are pages from a catalog of 67 years ago showing plug valves (they were known as cocks in those days) manufactured by Crane Co.

Shown also is one of the latest types of Crane Lubricated Plug Valves for oil, water, gas, gasoline, and air lines. Embodied in them is the sum of all the knowledge and experience gained in the 67 years that have passed since the making of those early valves.



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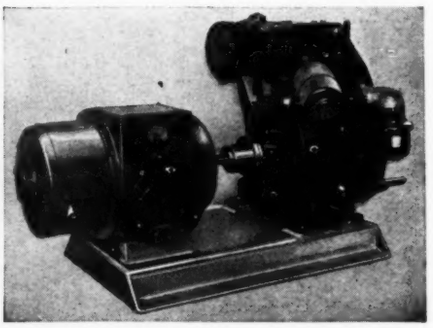
Lighting Plants

An interesting development in the field of electric generating units is a line of portable lighting plants recently perfected by the Harnischfeger Sales Corporation, 4400 West National Avenue, Milwaukee, Wis.

The small, heavy duty line of lighting units consists of a one- or two-cylinder gasoline engine directly coupled to a compound-wound, continuous generator. Push button or manual starting is available.

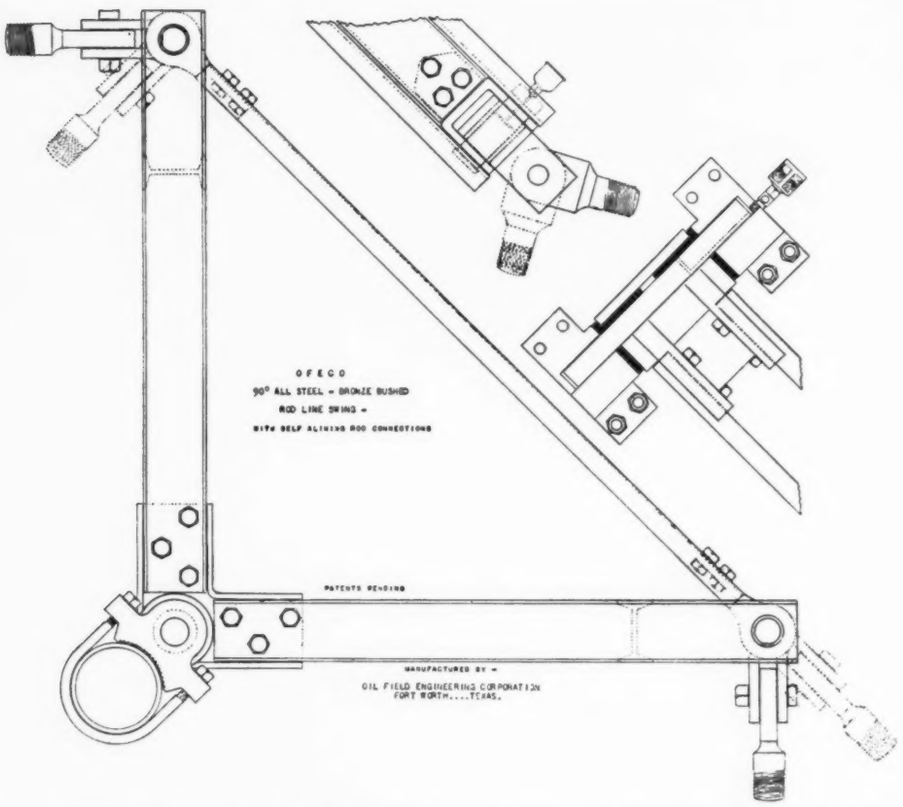
Capacities range from 400 watts to 3 kw., generating 35 to 120 volts direct-current. Greater capacities are provided for by four- and six-cylinder gasoline generator sets with a current range of 1½ to 60 kilowatts.



In addition to these gasoline-driven sets, Diesel power is also available. The Diesel engine generator sets are built in capacities of 35 to 40 kw., alternating- or direct-current.

Because of the large capacities of these units, electric lights and appliances may be operated simultaneously. Features claimed for the line are high reserve capacity, economical operation, simplified design and continuous non-flickering current.

All-Steel Self-Aligning Rod Line Swing



The Ofeco All-Steel Self-Aligning Rod Line Swing was developed to meet the popular demand for a swing that would not break under any pumping conditions, and would be free from friction so that its performance year after year would be constant without the necessity of replacement parts, according to the manufacturer, Oil Field Engineering Corporation, Fort Worth, Texas.

This swing is precision-built throughout and carefully balanced. Every part is of steel, and all moving parts operate on hardened and ground steel pins, in conjunction with bronze bushings, and positive oil or Alemite lubrication features are incorporated.

The self-aligning feature of the Ofeco Swing relieves twisting strains, so commonly destructive, and insures perfect operation regardless of the position of the rod line to or from the swing.

The main shaft housings are corrugated on the reverse side to grip the upright member to which it is fastened. The tie bolts are one in. in diameter to increase the safety factor.

This swing, which has a shipping weight of 1,000 lb., comes complete for installations, including the rod line connections.

Thread Compound

The use of metallic lead in a finely divided state as a thread dope is of interest to refiners and gasoline plant operators.

The makers of Bestolife, the new thread dope, claim a high percentage of that metal, free from oxides or oleates in their compound, forms a thin lead film that makes a seal and forms a gall-proof surface on threads. They claim, when applied to threads, that it is not affected by heat, even up to 1500 deg. fahrenheit.

Studs on headers and elsewhere will not twist off, and will easily unscrew, even months after application, leaving a perfect thread. Super-heated steam lines are easily taken apart after an application of Bestolife. Leaks seem to respond instantly to this new dope.

The makers claim a real saving in labor and material will be effected by the use of this new thread dope. For further information, write Armite Laboratories, 1900 East 65th Street, Los Angeles, California.

MacClatchie Pump Rods

The MacClatchie Manufacturing Company, Compton, Calif., has recently developed a solid type pump rod that it claims has three features essential to pump rod economy:

(1) By designing a rod nut with a taper that locks itself automatically to the threads of the rod, pistons are prevented from becoming loose on the rod. (2) As well as having a gripping effect on the piston and maintaining its hold this taper can be readily loosened when desired. (3) This universal rod eliminates the necessity of excessive stocks in company warehouses and supply houses.

The MacClatchie Sleeve Type Pump Rod has all the advantages of the solid type with the added advantage of having a sleeve that is replaceable at a fraction of the original cost.

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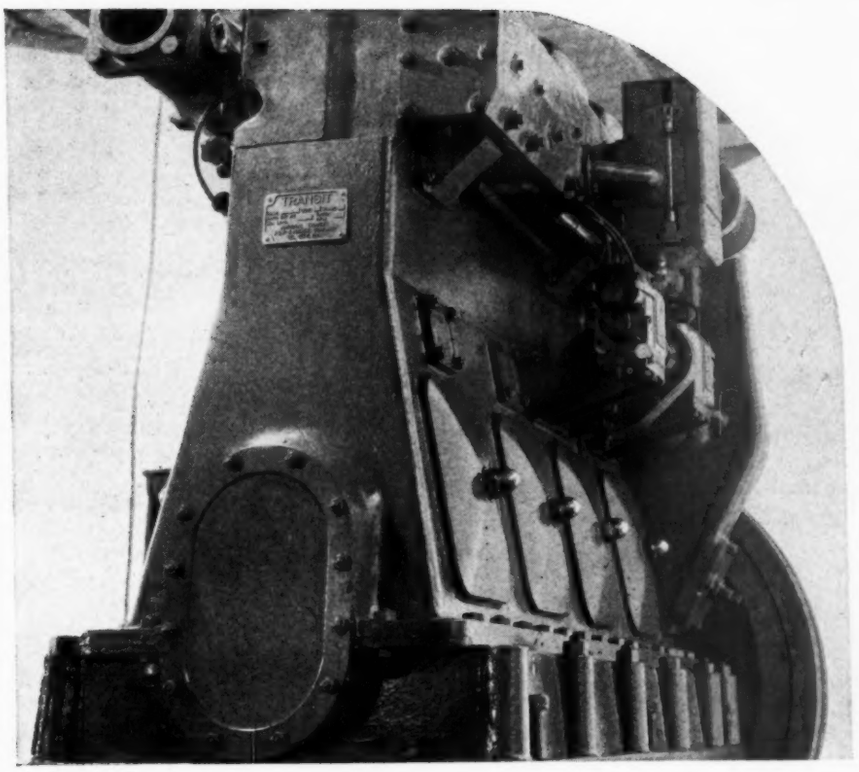

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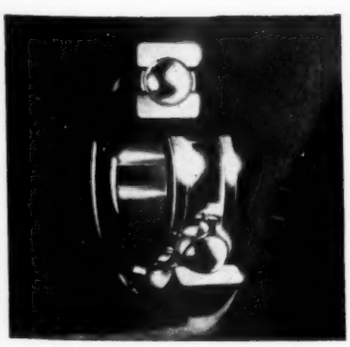


Gasoline Blending Chart

By GEORGE B. STEELE, New York Oil Company, Casper, Wyoming

The chart is based on the formula:

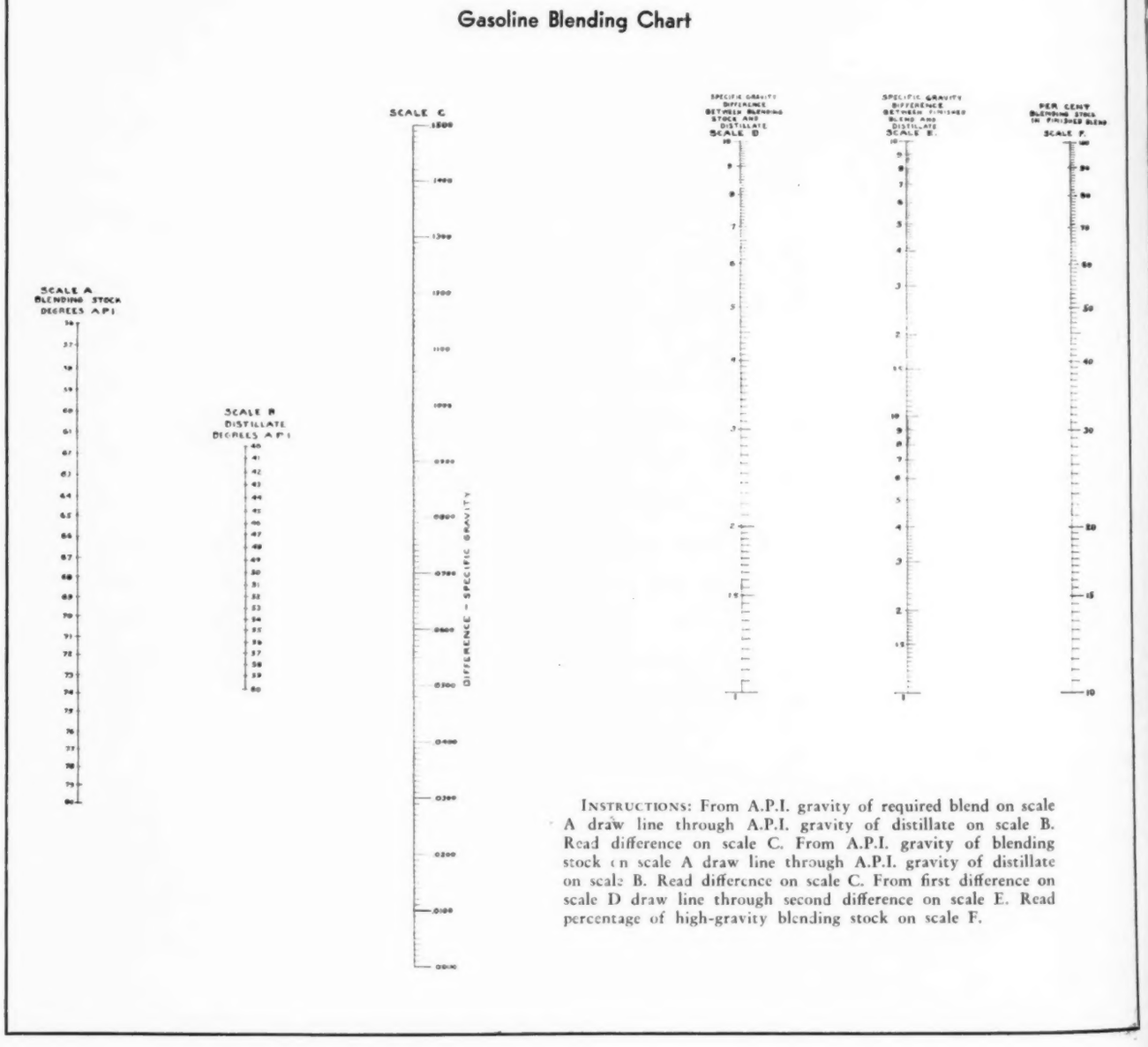
[Sp. Gr. distillate — Sp. Gr. finished blend] / [Sp. Gr. distillate — Sp. Gr. gasoline (blending stock or high test)] = Per cent gasoline in finished blend.

From this the calculation for any batch is:

Per cent gasoline/Per cent distillate = Ratio of gal. gasoline to gal. distillate.

To find the number of gallons of gasoline required to produce a blend of predetermined gravity, multiply the number of gallons of distillate by this ratio.

It is to be noted that although based on a formula involving specific gravity the chart reads directly in gravity A.P.I. thus conversion is not required. When used for blending operations requiring less than ten per cent gasoline care must be used to read scale F as having a total range of only ten per cent, and in selecting values on scale E.

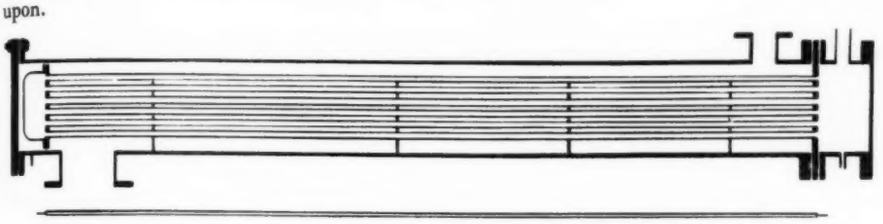

Gasoline Blending Chart
SCALE A
BLENDING STOCK
DEGREES API
SCALE B
DISTILLATE
DEGREES API
SCALE C
DIFFERENCE - SPECIFIC GRAVITY
SCALE D
SCALE E
SCALE F
INSTRUCTIONS: From A.P.I. gravity of required blend on scale A draw line through A.P.I. gravity of distillate on scale B. Read difference on scale C. From A.P.I. gravity of blending stock on scale A draw line through A.P.I. gravity of distillate on scale B. Read difference on scale C. From first difference on scale D draw line through second difference on scale E. Read percentage of high-gravity blending stock on scale F.

Electrical Oil Heater In Shanghai Plant

By M. A. deLEW
Associated Oil Company

BY reason of local conditions, the Associated Oil Company found itself compelled to use electrical energy for the production of the necessary heat for the blending of lubricating oils at its bulk plant, located in Shanghai, China.

The design of this heater was based on raising the temperature of 50 gal. of oil 50 deg. per minute, which in round figures required 116 kw.; therefore, 120 kw. was decided upon.



Left: Fig. 1
Right: Fig. 5
Below: Fig. 4

They adapted the surface condenser principle as the most feasible both from an electrical and mechanical standpoint. The interior is readily removable for cleaning and the electrodes also easily replaced. The design, while built upon conventional lines, is considerably elongated for the purpose of imparting heat slowly; the heating surface being limited to nine watts per sq. in. of tube surface.

Fig. 1 shows diagrammatically a longitudinal section through heater; the lower portion shows one of 30 electrodes. The movable end, covered by a bonnet, is to prevent oil that may seep entering the tubes and carbonizing. Thirty v.c. No. 10 conductors energize the electrodes. The length of electrodes is 11 ft. 6 in. over all; the diameter being ⅞ of an inch. The brass tubes of heater are one in. inside diameter.

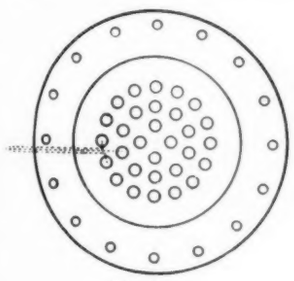


Fig. 2

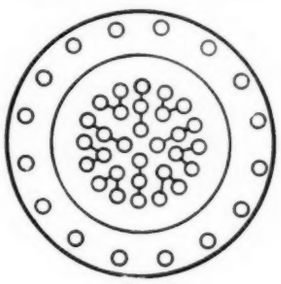


Fig. 3

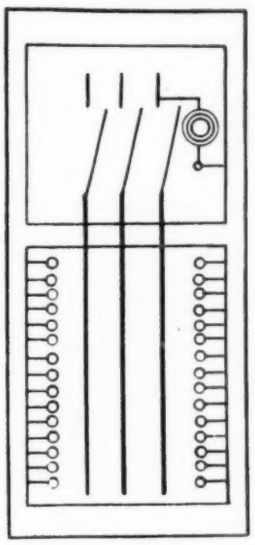
Fig. 2 shows method of connection to the panel. The service 330 volts, 50-cycle, three-phase, simplified the electrical work to a considerable extent.

Fig. 3 shows the terminals of electrodes star-connected as noted above.

Fig. 4 shows the distributing panel, which consists of 30 General Electric Company AF-1 thermally-controlled, circuit breakers. The load is controlled by a Diamond Electric Manufacturing Company 300-ampere three-pole contactor. Two-wire control was used in order to simplify the operation of a thermostat.

The control of the heating system and power rests in two Crouse Hinds Company vapor-proof switches, FA-128. For the purpose of more perfectly determining the "on" and "off" position of heating, a small Neon lamp indicates the energizing of panel bus bars. A three-gang box was used, the center switch removed and an obscure glass placed in cover, the Neon lamp directly underneath; the whole being remotely controlled from a point where processing is attended.

Fig. 5 shows the plan of electrode construction. These elements, four kw. each, are practically sealed against the admission of either dampness or air. Before sealing is completed they are brought up to 600 deg. and remain at that temperature for 30 minutes and while hot the ends



are sealed by silver solder. The terminal bolts are drilled to permit both the exhausting of electrode and the entrance of heating wire. The wire is jambed and holes filled after being subjected to heating as above noted.

After completion the apparatus was tested and found entirely satisfactory.

The heater was designed by the Associated Oil Company Refinery Engineering staff to accommodate the electrodes. The heater was manufactured at refinery shops.

The electrodes were manufactured by Wesix, Inc. The panel was designed and manufactured by the Diamond Electric Manufacturing Company.

We are indebted to the following gentlemen: W. C. North, International General Electric Co.; A. J. Kercher, Electrical Heating Engineer; W. W. Hicks, Wesix, Inc., and H. V. Mooney, Wesix, Inc., for their hearty coöperation and that of their companies, who provided the service.

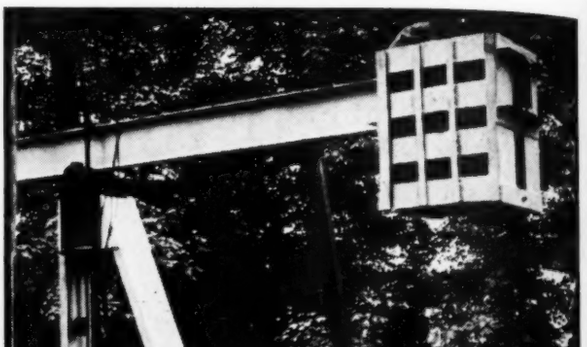
Welding of Well Pumping Equipment

WELDING is aiding producers by enabling them to modernize and revamp their old pumping equipment and place it on a more efficient basis. The Olean Petroleum Company, operating a lease near Mt. Jewett, Pa., in the western part of the state, recently decided to equip all wells with individual power plants. Their old equipment consisted of the usual central pumping station with steel cables running through the woods as shackle lines to the various wells.

Under the new plan, the company has installed a power plant with a gasoline engine for generating the current. Power lines running to the wells supply the 3-hp. motors that operate the pumps. It is believed that this will increase the efficiency and cut the cost of pumping operations. Much of the supervision formerly required will be eliminated due to the fact that a number of operating parts are done away with.

The principal structural parts going to make up these pumping units are six 10-in. channels, three 5-in. I-beams, one 8-in. I-beam, one 3-in. I-beam and 16-gauge steel for the fabrication of the V-belt drive guards. All parts were welded by the shielded arc process, using "Fleetweld" electrodes manufactured by The Lincoln Electric Company of Cleveland, Ohio.

Welding was also employed in hard-surfacing the well rod bearing which rests on the beam. For this purpose "Blackor," an abrasion-resisting tungsten carbide, applied with the carbon arc, was used.



Welded steel pumping unit in use in Western Pennsylvania

Orifice Meters Utilized in Fueling Graf Zeppelin

Photograph shows refueling at Akron before the Graf Zeppelin's recent homeward trip. The ship which burns gas instead of gasoline, has a capacity of 900,000 cu. ft., giving her motors a cruising radius of 6000 miles at 65 M.P.H.

At this refueling about 750,000 cubic feet of fuel gas were taken on board. Sixteen hours were required for the operation.

The fuel gas is approximately 65 per cent Pyrofax and 35 per cent hydrogen and has a specific gravity of 1.05.

To obtain the high degree of accuracy required in the measurement and mixing of these two gases, two American Meter Company Orifice Meters are utilized.

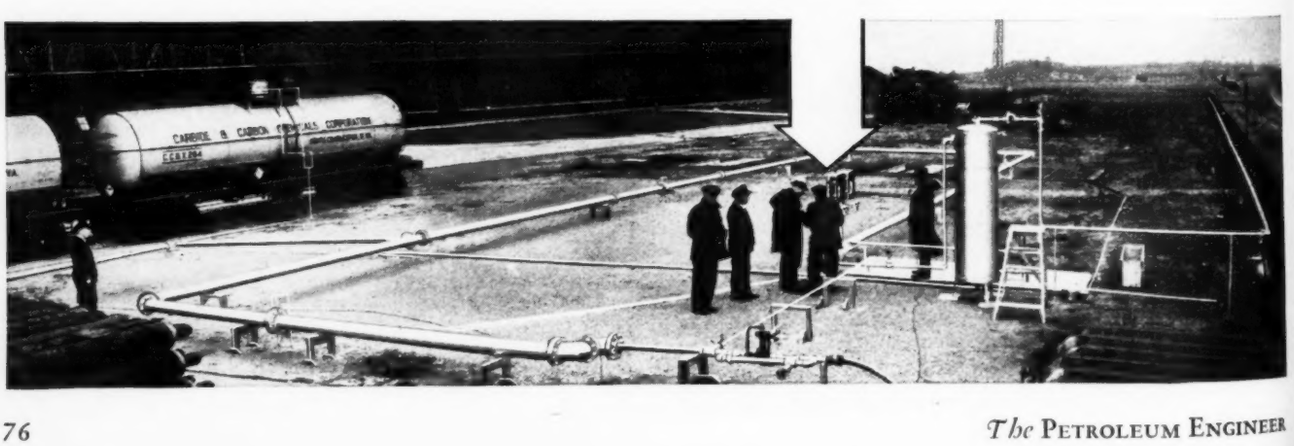
Pyrofax gas is introduced into one end of the piping layout and the hydrogen into the other. These gases are mixed at a common outlet, and then flow through a tunnel into the air dock. Liquefied Pyrofax is passed through a steam vaporizer, the steam being provided from the railroad locomotive shown on the siding. The hydrogen is brought in through a manifold connection and thence through a main control valve.

To maintain the temperature of the two gases constant and thereby eliminate the necessity for making corrections for flowing temperature, the hot Pyrofax gas from the vaporizer is cooled by refrigeration and the hydrogen is heated.

This setup for measuring and controlling the fuel gas is the same as that employed in past refuelings of the Graf in Tokio, Los Angeles and Lakehurst. A similar installation is used at the permanent Zeppelin refueling base in Pernambuco, Brazil.

Choice of American Meter Company instruments is evidence of international recognition of their accuracy . . . a degree of accuracy established in the displacement measurement of the smallest laboratory pilot light's flow and closely maintained through the entire range of applications.

Pyrofax gas was supplied and refueling operations were supervised by Union Carbide & Carbon Corporation. Photo is used by courtesy of Goodyear Zeppelin Corporation.



Appoint Correlating Committee on Rig and Derrick Lighting

The problem of derrick lighting arose in the first instance in the work of the Accident Prevention Committee of the American Petroleum Institute. This committee felt, however, that due to the engineering factors involved and the direct relation to fire prevention, that any recommended good practice should include: first, certain necessary engineering principles affecting design and illumination; second, fire prevention, and third, accident prevention. With the foregoing in mind, it has been deemed advisable to appoint a committee representative of these three groups.

The committee personnel of this committee is as follows: H. N. Blakeslee, American Petroleum Institute, Dallas, Texas; R. E. Donovan, Standard Oil Company of California, San Francisco, Calif.; E. S. Durward, Shell Petroleum Corporation, Houston, Texas; W. H. Meier, Atlantic Oil Producing Company, Dallas, Texas; B. A. Moeller, General Petroleum Corporation of California, Los Angeles, Calif.; D. H. Moore, Humble Oil & Refining Company, Houston, Texas; C. J. Nobmann, Shell Oil Company, San Francisco, Calif.; George F. Prussing, Union Oil Company of California, Los Angeles, Calif.; D. V. Stroop, American Petroleum Institute, New York City; and C. D. Watson, Carter Oil Company, Tulsa, Okla.

Royalty Charge on Ethyl Gasoline Eliminated

The Ethyl Gasoline Corporation has announced that there will be no gallonage charge on ethyl gasoline during 1934 and also that there will be reduction in the cost of tetraethyl lead to licensees. The announcement of Ethyl Gasoline Corporation was as follows:

"On mixtures of ethyl gasoline made on and after next January 1 and during the year 1934 there will be no gallonage charge. It may be necessary to reinstate a gallonage charge after next year, but we will await developments until next October before taking an action in that direction for the year 1935. The charge for lead shipped by us on and after January 1 and during 1934 for use in regular and ethyl gasolines will be .33 cent instead of .35 cent. The foregoing applies to lead for use in automobiles and for aviation gasoline."

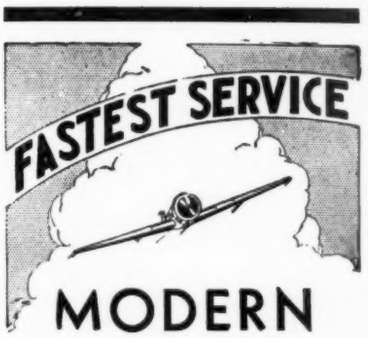
East Texas Export Shipment of Refined Products Is Large

Export shipments of refined products from East Texas was approximately 100 cars more than the combined interstate and intrastate movement during the eight days ended December 6, according to compilation of reports released by the Texas Railroad Commission.

Traffic in fuel oil, which took the lead from gasoline two weeks ago, continued to set the pace for all refined products, but its margin over motor fuel was diminished.

Recapitulation of shipments reported for the eight-day period shows 626 cars of fuel oil moved, against 611 cars of gasoline. A total of 918 cars were consigned for export movement, with 470 cars entering interstate traffic and 349 cars for delivery within the state of Texas.

Distillate, topped crude and gas oil shipments vied for the third position in total shipments. Shipments by days varied from 5 cars to 287.

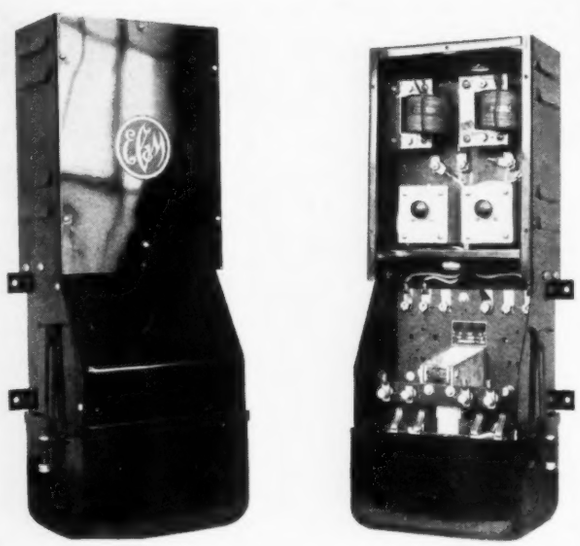


MODERN BUSINESS DEMANDS SPEED

For Faster Service between The Great Lakes and the Gulf, specify Bowen Air Lines in Texas and Oklahoma.

Bowen Air Lines

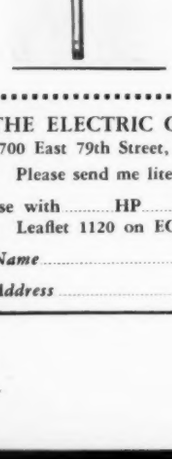
CENTRIFUGE
Motor Starters



Especially developed by EC&M for this severe starting duty

These are heavy-duty, oil-immersed motor starters especially designed not only to take care of the initial long-time starting required on centrifuges, but also to insure adequate protection against overloads and single-phase operation during running.

The overload relays employed in these starters are so designed that they practically duplicate the sensitive and accurate protection that is provided with a standard starter. This means that, although the starting period of a centrifuge is possibly five or six times that of the ordinary motor-driven machine, you can secure satisfactory operation and successful protection of motor-driven centrifuges with these starters.



A number of them have been working very successfully in the larger refineries for some time. Write for complete information.

EC&M Bearing Thermostats

For protecting pumps, motors, fans, compressors, etc., from breakdowns due to overheated bearings. They are easily installed and are inexpensive insurance against trouble, delays and costly replacements. Write for Leaflet 1120, describing them.

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Please send me literature describing EC & M Centrifuge Starters for use with ..... HP ..... Volt ..... Phase ..... Cycles Motors.
Leaflet 1120 on EC & M Bearing Thermostat.

Name ..... *Company* .....

Address .....

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Service as the Petroleum Industry Gives It

D. A. Sillers, Lone Star Gas Company, tells this one and vouches for its truthfulness:

A lady was driving from her home in Arkansas to visit relatives in Dallas. She stopped at a wayside filling station.

Lady: Do you have a rest room?

Attendant (who had noted the dirty appearance of the car and thinking she said "whisk broom"): No, we haven't, lady. But if you will just move it up here we will be glad to blow it out with the air hose.

* * *

Teacher: Who was the smartest inventor?

Pupil: Thomas A. Edison. He invented the phonograph and radio so people would stay up all night and use his electric-light bulbs.

* * *

A farmer was trying hard to fill out a railway company claim sheet for a cow that had been killed on the tracks. He came down to the last item: "Disposition of the carcass." After puzzling over the question for some time, he wrote: "Kind and gentle."

* * *

A Scotchman had been advised by his physician that he had a floating kidney. He was very much disturbed by the diagnosis and went to his minister with a request for the prayers of the congregation.

"I don't know," said the minister dubiously. "I'm afraid that at the mention of a floating kidney the congregation would be inclined to laugh."

"I don't see why they should," replied the suffering one. "It was only last Sabbath you prayed for loose livers."

* * *

Rastus: Liza, will you go riding in mah Ford?

Liza: I won't do nothin' else.

Rastus: Then you can't ride in mah Ford.

* * *

Misdeal!

The woman bridge expert, worn out from her long ordeal, wearily asked the nurse to bring in her new-born babe.

The nurse departed and returned a few minutes later bearing a baby in each arm. The mother gave one look and raised herself up in bed.

"Good heavens!" she cried out, "someone doubled me while I was vulnerable!"

* * *

Warden: Well, young man, they're about to give you the juice. Have you any last request?

Condemned Criminal: Yea, make it orange juice.

—*Louis Allis Messenger.*

* * *

Lawyer: What did you say when you saw the automobile approach the railroad tracks?

Watchman: I said, "That is a fine car, wasn't it?"

* * *

Two oil executives were growling about their wives. One spoke up. "Do you know that your wife is telling her bridge club friends that you can't keep her in clothes?" The other smiled wryly, and answered: "That's nothing, I bought her a home, but I can't keep her in that either."

New Line to Take Gas from Hebron Field

The New York State Natural Gas Corporation recently completed the construction of a 39-mile, 10-in. pipe line extending from the Hebron natural gas field eastward to the Tioga gas field, where it connects into the 100-mile, 20-in. Syracuse line that supplies gas to the city of Syracuse, N. Y. This new line is the third outlet from the Hebron field, which was discovered in November of 1931.

The Hebron field is located in the north central part of Potter County, Pa., about five miles from Coudersport. The first well was drilled in December, 1931, and had an initial open flow of 9,000,000 cu. ft. with an initial rock pressure of 2200 pounds. At the present time, there are 12 producing wells in the field with a total open flow of approximately 210,000,000 cu. ft. The gas comes from what is known as the Oriskany sand, found at a depth of from 5,000 to 5300 feet.

The same type of construction was used on the new 10-in. line as was used on the 100-mile Syracuse line which it serves, viz., plain-end steel pipe joined in the field with Dresser couplings. The 10¾-in. OD steel pipe was supplied in 40-ft. lengths, each length consisting of two 20-ft. sections welded together at the pipe mills. The field construction work was done by Mitchell & Stewart, of Dallas, Texas.

Much of the right-of-way lay through thickly-wooded mountainous country. The narrow trench, 16 in. wide by 42 in. deep, was dug for the most part by machine. Where the "going" was extremely rough, hand digging was resorted to.

The pipe-laying construction crew consisted of 24 men, 12 of whom assembled from 75 to 132 Dresser joints per eight-hour day, depending upon right-of-way conditions; through good country the crew laid a mile of line per day.

All the necessary pipe bends were made cold in the field with the aid of two tractors. The pipe was laid by coupling a number of lengths above the ditch on skids and lowering the assembled line in sections, always keeping the end of the completed line above the ditch. The back-filling was done by tractors as the construction progressed.

The line was tested at 600 lb. pressure and will operate under a working pressure of 300 to 350 lb. per sq. inch.

Struthers-Wells Appoints Rocky Mountain Distributors

The Mine and Smelter Supply Company, 1422 Seventeenth Street, Denver, Colo., has been appointed sales representative for the Struthers-Wells Division of the Struthers-Wells Titusville Corporation, Warren, Pennsylvania, and will handle the sale of their pressure vessels, oil refinery and chemical process equipment in the Rocky Mountain District.

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TEXAS STATE HOTEL
Home of the Famous
TEXAS STATE Grill

International Exposi to Be La

The largest show of inventions, new equipment and devices used in the oil industry, a larger marketers' display, and decreased space rates will feature the eighth International Petroleum Exposition and Congress which will be held in Tulsa, May 12 to 19, according to W. B. Way, general manager.

The first information concerning the exposition has been sent out to the more than 325 exhibitors at the last show held in 1930 and to other prospective exhibitors, and advertisements announcing the exposition are being run in leading oil publications, Way announced.

"The general wave of reconstruction prevailing in the industry due to the increased price of oil and a partial balance between supply and demand is fomenting planning among producers and refiners for immediate improvement of their properties and extensive construction work and additions to equipment," said Way.

"This means that now is the opportune time for manufacturers to display new machinery and inventions which have been perfected by engineers and scientists over the past three years and which, due to depressed business conditions, have not as yet been generally introduced to the industry. This is the reason we believe we will have the largest show in the history of the oil industry.

"In the past few years many oil firms have added many bi-products and accessories to their lines and are marketing them through their regular service stations. These firms will find it profitable to introduce new lines to the public and further acquaint it with established lines at the exposition."

Due to the fact that the International Petroleum Exposition and Congress, which is a non-profit institution owned by the oil industry, now has a complete plant, the executive committee this year decided to decrease space rates 10 per cent for inside building booths and 50 per cent for open air space.

Improvised buildings thrown together in two blocked-off streets formed the humble beginning of the International exposition in Tulsa in 1923, and since that time the institution has grown in size and importance and now has a permanent exhibit plant.

Termed the "World's Fair of the Oil Industry," the exposition has been recognized as an international institution since its beginning, being attended by representatives from almost every nation. Delegates from more than twenty nations attended the last show and with the recognition of Russia and the three-year interval plus the business depression it is expected that foreign exhibits and delegations will be even greater next May. Between four and five hundred firms are expected to exhibit, according to Way, who makes the estimate on the basis of previous contracts for space.

Since the announcement in the press in November when

Exposition Expected Be Large

the board of directors of the exposition, meeting in Tulsa upon call of President W. G. Skelly, during the annual convention of the Independent Petroleum Association of America, approved the exposition dates, nearly a hundred letters from leading oil men, refiners, and equipment men of the nation have been received at the headquarters, pledging support and heartily approving the show.

The May exposition has been endorsed by the Independent Petroleum Association and Mid-Continent Oil and Gas Association.

Twenty new members have been named to the board of directors, Way announced. They are:

Earl Sneed, Sneed Petroleum Co., Tulsa; Walter Fleming, Marathon Oil Corporation, Tulsa; Peter Lieb and John Conry, Carter Oil Co., Tulsa; John H. Crawford, Parkersburg Rig and Reel Co., Parkersburg, Pa.; Edward H. Salrin, Tidewater Oil Co.; Henry Phillips and William Connelly, Sinclair-Prairie Co.; Charles Urshel, Oklahoma City; Clarel Mapes, Mid-Continent Oil and Gas Association; R. E. Ellison and R. O. Dietler, Santolind Oil Co.; A. E. Bradshaw, president of Oklahoma Natural Gas Co.; Rush Greenslade, Gypsy Oil Co.; E. R. Filley and Jess Hill, Texas Co.; Harry Weiss, Humble Oil Co., Houston; Hugh Stalcup, Skelly Oil Co.; W. J. Morris, Continental Supply Co., Dallas; D. C. Williams, president, Natural Gasoline Association, Ponca City, Oklahoma.

Directors who are members of the board from the last exposition in 1930 are: Clyde Alexander, Phillips Petroleum Co., Bartlesville, Okla.; R. H. Bartlett, president, The Braden Co., Tulsa, Okla.; Frank R. Billingslea, Tulsa; A. F. Bourne, secretary-treasurer, Oklahoma Iron Works, Tulsa; W. M. Bovaird, president, Bovaird Supply Co., Tulsa; J. H. Brooks, vice-president, Republic Supply Co., Tulsa; E. J. Bullock, vice-president, Standard Oil Co. (Indiana), Chicago; Ernest H. Cornelius, president, Oklahoma Steel Castings Co., Tulsa; O. T. Dawson, division manager, The National Supply Co., Tulsa; R. E. Day, president, Magneto Ignition Co., Tulsa; C. P. Dimit, Phillips Petroleum Co., Bartlesville; Ray L. Dudley, president, Gulf Publishing Co., Houston, Texas; George A. Dye, vice-president, H. F. Wilcox Oil and Gas Co., Tulsa; John M. Egan, general manager, Oil and Gas Journal, Tulsa; W. S. Farish, Standard Oil Co. (New Jersey), New York; W. S. Fitzpatrick, chairman of the board, Sinclair-Prairie Co.; J. P. Flanagan, Tulsa; H. V. Foster, president, Indian Territory Illuminating Oil Co., Bartlesville; Jacob France, president, Mid-Continent Petroleum Corporation, Baltimore; Wirt Franklin, Wirt Franklin Petroleum Corporation, Ardmore, Okla.; Robert F. Garland, Tulsa; J. Burr Gibbons, Tulsa; Walter Gray, district manager, Jarecki Manufacturing Co., Tulsa; Henry Greis, president, Burke-Greis Oil Co., Tulsa; A. A. Guiberson, Jr., The Guiberson Corpora-

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That's the secret—a tool steel heat-treated blade held on a solid hub, a better cutting tool than can be made any other way. Note also that the cutter housing is steel reinforced and flatly guaranteed against breaking or warping. Altogether a nicely balanced, slick-working tool. Try it and see. Your Supply Store has it.

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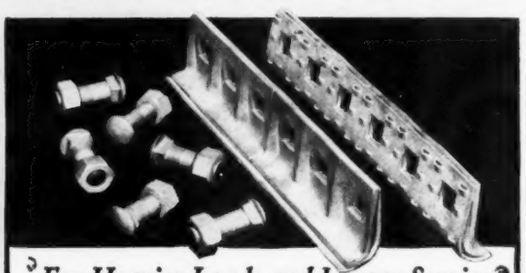

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Individually packed in sealed boxes—complete with bolts and nuts

"They have the stuff in 'em these Harrisburgs"

THAT'S the story you will get from veterans who have put all sorts and makes of oilfield equipment through their paces.

Harrisburg forged and seamless steel units "have the stuff in 'em," because away back in the very beginning of their manufacture Harrisburg metallurgists saw to it that the steel was right. Harrisburg makes its own steel — to suit the product.

Harrisburg oilfield products: seamless steel pipe couplings, bull plugs, and pump liners; steel pipe flanges; tool joint, casing, and drive shoe forgings.

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tion, Los Angeles; P. D. Hays, National Bank of Tulsa; J. M. Hayner, vice-president, Phantom Oil Co., Tulsa; Alf G. Heggem, president, Oil Well Improvements Co., Tulsa; Frank J. Hinderliter, president, Hinderliter Tool Co., Tulsa; William Holden, general manager, Tulsa Chamber of Commerce; R. C. Holmes, New York; B. E. Horrigan, Tulsa; Fred W. Insull, president, Public Service Co. of Oklahoma, Tulsa; Roy B. Jones, president, Panhandle Refining Co., Wichita Falls, Texas; A. W. Leonard, vice-president, Devonian Oil Co., Tulsa; Joseph R. McGraw, president, McGraw Oil Co., Tulsa; D. F. McMahon, Tulsa; Walter Miller, vice-president, Continental Oil Co., Ponca City; P. M. Miskell, Empire Oil and Refining Co., Tulsa; Harry J. Morlang, vice-president, Oil Well Supply Co., Dallas; C. Morris, president, *Petroleum Engineer*, Dallas; E. J. Nicklos, vice-president, Continental Oil Co., Ponca City; Clyde Pape, secretary-treasurer, Selby Oil and Gas Co., Tulsa; F. B. Parriott, president, Trans-Continental Oil Co., Tulsa; A. W. Peake, Standard Oil Co. (Indiana), Chicago; J. Edgar Pew, vice-president, Sun Oil Co., Philadelphia; Waite Phillips, Tulsa; Warren C. Platt, president, National Petroleum News, Cleveland, Ohio; Ralph B. Pringle, vice-president, Tidewater Oil Co., Tulsa; F. O. Prior, president, Dixie Oil Co., Tulsa; E. B. Reeser, president, Barnsdall Oil Corporation, Tulsa; Harry H. Rogers, Tulsa; E. J. Sadler, director, Standard Oil Co. (New Jersey), New York; J. H. Satterwhite, manager and assistant treasurer, Westcott and Geis, Tulsa; W. A. Schlueter, president, Refinery Supply Co., Tulsa; W. G. Skelly, president, Skelly Oil Co., Tulsa; O. C. Staples, Frick-Reid Supply Co., Tulsa; M. F. Waters, president, Hanlon and Walters, Tulsa; D. D. Wertzberger, president, Wertzberger Derrick Co., Tulsa; T. R. Weymouth, Columbia Gas & Electric Co., New York.

Rush Greenslade Named Vice-President and General Manager Gulf Subsidiaries

Rush Greenslade of Tulsa, Okla., has been named vice-president and general manager of the Gypsy Oil Company and Gulf Pipe Line Corporation of Oklahoma, northern Mid-Continent subsidiaries of the Gulf Oil Corporation of Pittsburgh, Pa. Greenslade spent his early life at Lima, Ohio, and after graduating from a law college in the Buckeye state, removed to Muskogee shortly after Oklahoma became a state. In 1914 he joined the Gypsy-Gulf legal staff in Tulsa and has advanced in that work until today he heads this far-flung operation. Mr. Greenslade succeeds Kendall Winship, deceased.

Bristol Company Organizes Canadian Subsidiary

The Bristol Company of Waterbury, Conn., has announced that after December 1, 1933, its Canadian business is being handled by a separate company, The Bristol Company, Ltd., of Canada, with manufacturing, sales and service headquarters in Toronto. Powerlight Devices, Ltd., Montreal and Toronto, continue as authorized distributors for the provinces of Quebec and Ontario.

Midwest Chemical Meeting to Be Held at Kansas City

The twelfth midwest regional meeting of the American Chemical Society will be held in Kansas City, Mo., May 3, 4 and 5. Arrangements are being made for a group of papers relating to the petroleum industry as a part of the program. Dr. Roy Cross of the Kansas City Testing Laboratory is chairman of the petroleum group and H. M. Steininger of the Standard Oil Company of Indiana, Sugar Creek, Mo., is its secretary.

Mr. Steininger has requested that anyone having a paper for consideration get in touch with him through the Kansas City office, 700 Baltimore Avenue.

Wilson Supply Appointed Sievers Reamer Distributor

The Security Engineering Company of Whittier, Calif., has announced the appointment of Wilson Supply Company, Houston, Texas, as Gulf Coast and Mid-Continent distributor for the Sievers Reamer. This appointment will give Gulf Coast and Mid-Continent operators an improved service on this reamer. In commenting on the addition of this product to their stock, Wallace Wilson, president of Wilson Supply Company, was confident it would win immediate acceptance.

The Sievers Reamer incorporates the same principle in an oil well reamer that is employed in an orchard disc. The cutters are sharp-edged discs and remove the formation with a knife-like cutting action. These cutters, designed in "barrel" shape, are set at an angle, so that when rotating they contact the hole as three distinct arcs with a combined length equal to 28 per cent to 45 per cent of the circumference of the hole. This not only keeps the hole round and free of any tight spots, but is a sound stabilizer for the bit.

The angular pitch of the cutters causes a positive turning action that prevents the cutters from wearing flat. The cutters turn in the same general direction as the tool, thereby not allowing cuttings or pebbles to lodge in the serrations and retard cutting.

The Sievers Reamer was used exclusively on the world's record deep well, Lillis & Welsh No. 1, Kettleman Hills, California.

Lower Pipe Line Rates in Texas

A Railroad Commission order establishing fixed rates for common carrier pipe lines operating in Texas became effective December 1, with a consequent saving to shippers of several million dollars annually. This is the first time such an order has ever been issued by the Railroad Commission.

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Improved in design, materials and workmanship, handier, stronger. Features include: Forged-in lugs that give jaws greater bearing on the bar; large steel bolt; drop-forged alloy steel shackle; jaws of special steel, hardened, tempered and tested; handles forged from high carbon steel, have both stiffness and spring; chains proof tested to two-thirds catalog strength (3,600 to 40,000 pounds).
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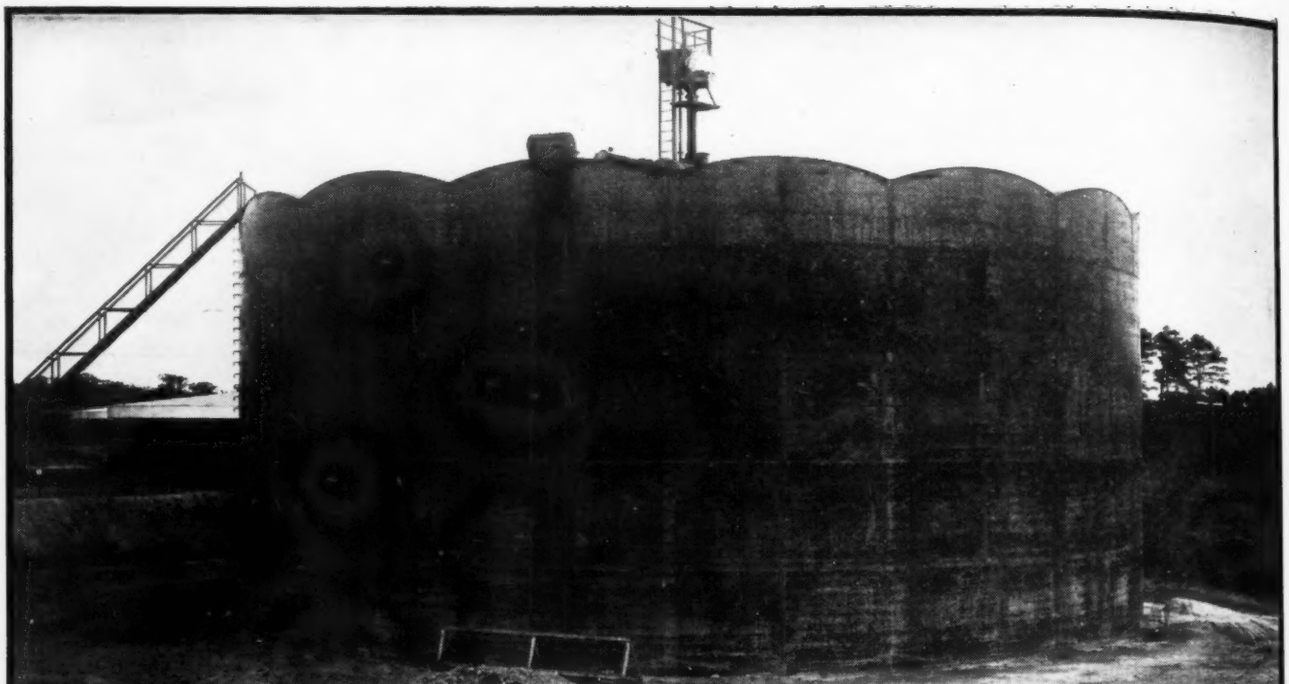


Completed 38,000-bbl. natural gasoline storage tank

Unique Design Eliminates Losses in Natural

TWO new pressure storage tanks, the largest high-pressure units ever designed and the first of their type to be constructed, were completed recently at Houston, Texas. The tanks, used to store casinghead gasoline, were built for the Warren Petroleum Company. One of the tanks is of 38,000-bbl. and the other of 55,000-bbl. capacity. They are designed to hold natural gasoline under a pressure of six lb. per sq. in. gauge or 20.7 lb. per sq. in. absolute.

The appearance and construction of these tanks are unusual, compared with those of the ordinary type. The 38,000-bbl. tank is 86 ft. in diameter and 38 ft. in height. The larger tank is 100 ft. in diameter and 42 ft. in height. They have a vertical cylindrical shell, the tops and the bottoms are convex on the outside so as to form a pressure dome of the radial cone type. The convex top also provides excellent water drainage. A vertical center cylinder serves to take the end reactions of a series of radical I-beams extending to the shell at both the top and bottom. These I-beams are tied together at certain definite intervals by vertical columns, connecting the top and the bottom beams. They act as staybolts would in a boiler. The roof plates are elements of cone sections welded to the radial beams with the concave surface underneath. In one of the accompanying photographs the scalloped appearance of the shell shows the outer end appearance of these roof cone sections.

The bottom plates are similar to the roof plates, concave on the inside and dished outward to take pressure.

All seams in these tanks were made by electric welding, using the shielded arc process, producing joints that have greater tensile strength than the present metal; and the deposited material is more ductile and less susceptible to corrosion than the parent metal. Fleetweld rods were used throughout.

The roof plates are butt-welded to the tops of the radial I-beams and the lap-welded to each other in each cone section. The bottom plates are butt-welded to the lower flange of the radial I-beams and are lap-welded to each other in each cone section.

The shell plates are all square-sheared and butt-welded together without the use of straps, lugs or rivets. They are welded both inside and outside. When the shell was tested full of water and with 7½ lb. per sq. in. air pressure there was not a seep in the shell.

The tank grade was prepared in the usual manner, soft places being filled with sand and rolled with road roller. A flat grade was turned over to the tank contractor. When the bottom plates were being placed in position, a sand having some clay in it was tamped into position and shaped to take the curved bottom plates before they were placed in position. In this manner, the grade was made to the true shape of the tank bottom. The shell plates extend vertically downward past the connection with the bottom plates and this skirt holds the sand cushion in place so that it cannot flow. The shell plate is butt-welded inside and outside to the roof plates,

Natural Gasoline Successfully Held in Storage at High Pressures Without Evaporation Losses

By WARREN L. BAKER

and the bottom plates are butt-welded against the shell over a 1-in. square backing-up bar, which was welded to the shell plates in the shop.

The most unusual feature of these tanks is the design, which eliminates the loss of liquid by evaporation. In the center of each tank is a small storage tank containing 100 gal. of glycerine. This is used in connection with an automatic regulating device. The tanks must vent to atmosphere through this liquid-sealed vent. The operation is such that the gas pressure must raise the column of glycerine sufficiently high to produce 6-lb. pressure before the gas can escape to atmosphere through the stay-tite approved flame arrestor. In other words, when the pressure in the tank exceeds six lb., the glycerine rises to the top of the column and acts as a safety vent to permit the gas to vent to atmosphere. When the pressure is released this liquid returns to the storage tank.

The liquid operates a float in the top box that opens and closes the vent plates. The vent operates at 1½ in. of water vacuum and will handle 10,000 bbl. per hour, pumping capacity either direction. The 38,000-bbl. capacity tank has been in operation for a period long enough to give it a thorough test, and has not lost a fraction of an inch of natural gasoline by evaporation.

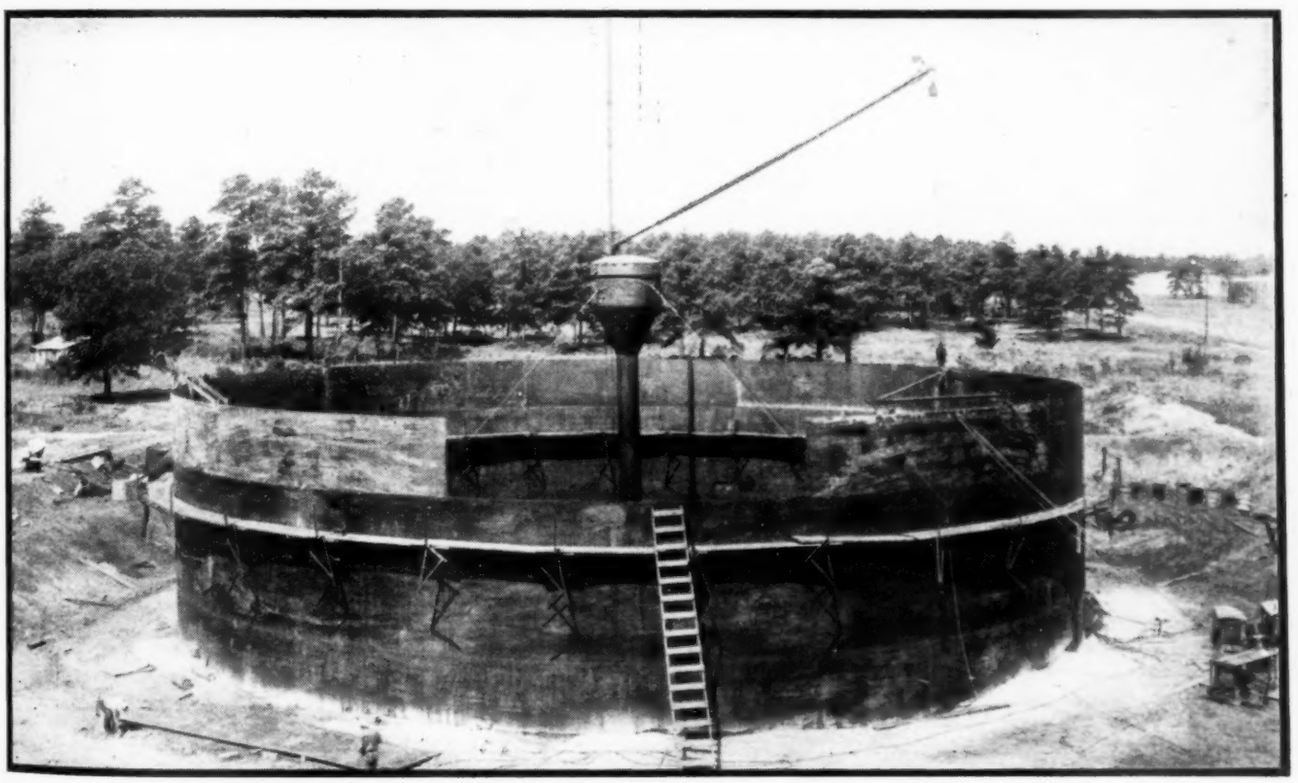
These tanks are being equipped with recording pressure gauges and recording thermometers. The records from these instruments will be taken over a year's period and it is expected that some valuable information covering the liquid surface temperatures and resultant gauge pressures for the different kinds of natural gasoline held in storage will be obtained.

These tanks will enable the Warren Petroleum Company to keep on hand and ready for immediate tanker loading, any grade of stabilized natural gasoline up to 22 lb. Reid Vapor Pressure without encountering the excessive evaporation losses that result from holding natural gasoline above 12 to 14 lb. in ordinary storage. This modern equipment is another forward step of natural gasoline manufacturers in their efforts to serve coast-wise and export customers.

These tanks and fittings were designed and constructed by the Chicago Bridge & Iron Works, using welding equipment manufactured by The Lincoln Electric Company, Cleveland, Ohio.

Storage Gasoline Tanks

The 55,000-bbl. tank while under construction



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The New Engineering Fundamentals Department (See page 35)

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New Educational Motion Picture Film Visualizes Foreign Oil Lands

An educational motion picture film depicting "A Trip Through the Oil Lands of Europe and Africa," is the latest addition to the film library of the United States Bureau of Mines, visualizing the mineral and allied industries. The film, which is in three parts, without sound, was prepared under the Bureau's supervision in coöperation with one of the country's large oil companies.

Part I consists of two reels which depict the oil fields of Germany, France, Spain, Morocco, and Algeria, and show many interesting and instructive episodes in the life and customs of the inhabitants of these countries, as well as scenes of their cities and points of historical and commercial interest. Reel one takes one through Germany and France, reel two to Madrid, Toledo, Granada, the Moroccan seaport Ceuta, Tangier, Fez, Oran, Medjiliah oil fields near Tiluanet, and to the "Tombs of Holy Men."

Part II consists of three reels. These portray the oil industry of Italy, Hungary, the Danube, and Rumania and show many points of historical interest in these countries. Reel one shows scenes in Venice of Rialto, Rialto Bridge, Grand Canal, Ca d'Or palace, St. Mark's Cathedral, and Bridge of Sighs. Hungarian scenes depict people in fête-day costumes, the Danube River below Budapest, Trajan's road along the river bank; Island of Ada Kaleh; and the famous iron gates at the eastern end of Kazan Pass. Reels two and three show scenes in Rumania and episodes in the life and customs of the people.

Part III consists of three reels dealing with the oil industry of Poland, Greece and Egypt. These reels picture the primitive life of Polish peasants, the ruins in Greece—the Acropolis at Athens, old temples, theater of Dionysius, the Erectheion and Parthenon; ruins and Hall of Initiations at Eleusis; and various Egyptian views, including gates of Cairo, tombs of caliphs, Pyramids and Sphinx, tomb of King Tut-ankh-amen; temple of Rameseum with colossal figure of Rameses; the town of Luxor of site of ancient Thebes; and temples of Karnak with pillars in hypostyle hall. The life and customs of Greece and Egypt are depicted in street scenes and natives at various occupations.

Although this series was produced primarily for the purpose of depicting the oil industry of these countries, it would have been incomplete without showing the many historical points of interest, the scenic beauty of the countries, and the customs of their people.

Copies of this film, "A Trip Through the Oil Fields of Europe and Africa," in both the 16-millimeter and 35-millimeter size, may be obtained for exhibition by schools, churches, clubs, civic and business organizations and others, from the Pittsburgh Experiment Station of the United States Bureau of Mines, Pittsburgh, Pa. No charge is made for the use of the film, although the exhibitor is asked to pay the transportation charges.

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